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THE AMERICAN MUSEUM OF SAFETY DEVICES.

By Herbert T. Wade.

It is a great satisfaction to be able to follow our recent publications descriptive of Continental institutions by this account of the first American museum of safety devices. The economic arguments for the support of the undertaking are so well advanced by Mr. Wade, that we need not add here to our preceding pleas in advocacy of the cause.—THE EDITORS.

AN interesting exhibition designed to show the best methods of safeguarding workmen and protecting the general public has been held in New York during the present spring by the American Museum of Safety Devices and Industrial Hygiene. This exhibition was of great importance in demonstrating that much of the loss of life incident to industrial operations in the United States is preventable, and that there are already developed methods and appliances that accomplish much in this direction. The subject already is attracting much attention from practical men such as the directors of large corporations and manufacturers as well as students of social science and men and women earnestly and practically interested in social betterment. It was the hope of those by whom the exhibition was organized that such further interest would be aroused as might lead to a much needed permanent museum of safety devices, which European experience has shown is a most powerful agency for increasing measures and methods to secure protection from injury and to safeguard the health of the industrial population.

In fact on the Continent of Europe the museum of safety and life-saving devices is now a recognized institution, usually conducted by the government or at least under government auspices. It has been found most valuable in instilling among wage earners an appreciation of safety devices that not only prevent accidents, but often improve

the operation of machine or plant from a mechanical standpoint. The museum was found the most practical way of educating the people to appreciate the gravity of the situation, and, just as in natural history, its influence was found to be as great with the children and the everyday workingman as it was with the manufacturer and student of social conditions.

This movement in Europe, where government supervision of industrial conditions, especially so far as dangerous trades and occupations are concerned, is far more strict than in the United States, attracted the attention of social workers and manufacturers interested in the protection of their employees. The subject of safeguarding industrial workers presented so many aspects, ranging from the financial interest involved in the greater or less liability of the employer for injuries to his workmen, to the altruistic point of view of the humanitarian, that the museum of safety devices soon came to be recognized as a distinct force for industrial betterment and one which on the practical side distinctly was workable. This was brought about in much the following way: Here is a dangerous occupation, and the conditions under which it is carried on are clearly shown in the museum. An inventor or manufacturer realizing that he has something that may cut down the risk in one or more respects, submits his device to the museum, where it is passed on by a technical commission, so that before it is accepted it is pronounced practical and workable. Once in the museum it is shown for the benefit of all, employer and employee, engineer and student, government inspector and legislator. Now if the device will diminish the liability of accident for which an employer may be held liable, and which if not involving a direct indemnity payment yet may mean the loss of a skilled workman, he is led to consider whether from an economic standpoint its introduction may not prove a good investment. The workman on the other hand seeing such a device and realizing its applicability to his particular work may try to secure its use. The government, moreover, has the opportunity of knowing and testing just what devices are available, what opinion of their value is held by those interested, and thus when regulations are promulgated can adopt those that, being practicable and workable, can be carried out firmly and intelligently. Such a museum stimulates inventors either directly as by prizes and medals, or by affording them an opportunity to exploit their inventions.

The deaths in the United States from railway accidents and fire, to mention but two causes, are a national disgrace, while the conditions in various industrial occupations in which injury or accidental death is all too frequent, or which are carried on under unsanitary

A CONTINENTAL EXAMPLE FOR COMPARISON. THE MUSEUM OF SECURITY AT BERLIN.

By courtesy of *American Industries.*

conditions, are hardly less serious. It is of course possible to assign reasons for this apparent disregard of human life that are satisfactory as explanations, but not as excuses. The national temperament with its haste and impetuosity, the sudden recklessness developed by the immigrant free from the firm restraint of his native land, the rapid growth of individual manufacturing plants as well as great industries where immediate returns rather than permanence and stability are the prime essentials, the carrying on of business with inadequate machinery often involving overloading, the laxity or absence of State inspection, the lack of a proper spirit of concern for the welfare of the employed, the ignorance and carelessness of the working classes, and finally the national vice of taking chances rather than observing proper precautions in providing and operating machinery, are equally characteristic of superintendent and workman. These reasons and many more are given for the condition of affairs mentioned, and it would appear that the whole matter could be summed up in the word *indifference.* Now to remove this indifference, education is necessary, and as the museum has been found the simplest and most direct way, such an exhibition was arranged early in 1907 and was held under the di-

A GENERAL VIEW ACROSS THE GALLERY OF THE MUSEUM.

The fire-extinguishing and fireproofing exhibits are in the foreground. Next to the right is the safety door and the railway signalling apparatus. The boat launching device is in the middle distance.

rection of Dr. Tolman at the American Museum of Natural History, a number of manufacturers contributing exhibits of safety appliances. The interest evolved was sufficient to induce the committee of direction of the American Museum of Safety Devices and Industrial Hygiene to arrange for a more permanent exhibition in quarters of its own with the hope of arousing sufficient public interest to put the enterprise on a firm basis with some guarantee of its permanency. Whether this end has been attained or not it is impossible to say before the close of the exhibition, but that the work otherwise has been successful is evidenced by the intelligent appreciation of the visiting public.

In its general character the exhibition was a collection of devices, models, photographs and charts, obtained from manufacturers, inventors, foreign museums of safety devices, boards of health, casualty companies, and students of industrial conditions, the whole possessing a reasonably comprehensive character and showing what is being done in various countries to improve industrial and sanitary conditions. Like every exhibition including miscellaneous mechanical devices, there naturally was a great difference in the value of the exhibits ranging from new inventions, many of which obviously were of rather doubtful value, to those of such recognized commercial success as the air-brake and wire-glass, to mention but two devices now so commonplace and essential. In this way was made apparent the great commercial importance and value of successful safety devices, while an interesting collection of photographs from the best American machine shops indicated the use made of such protective devices under conditions where the best practice was observed, showing how profitable and reasonable the use of such machinery was considered. A collection of clippings from newspapers reporting various accidents was prominently displayed, but it was only the collection and the bringing together of so many similar items from all over the United States—not the individual articles—that impressed the average visitor, so commonplace was this sort of information. Perhaps more impressive were the photographs of the scenes of various accidents, which plainly showed that many of them could be prevented by the use of the simplest precautions. Then there were the silent witnesses in the form of plates from defective boilers, portions of failed gear or fly-wheels, broken blocks and hooks, each with the sad story of death and accident which suitable forethought and inspection would have obviated.

Many of the various safety devices and protected machines were in operation during the exhibition, and where full-size machines were

ANOTHER NOTEWORTHY CONTINENTAL EXAMPLE. THE ROYAL BAVARIAN INDUSTRIAL MUSEUM.

Machinery hall, and collections illustrative of accidents and their causes.

not available or feasible, numerous models or photographs were shown. Perhaps the most striking feature of the exhibition was its diversity, extending as it did from automatic launching lifeboats to protected elevator shafts and circular saws. Indeed some of the simpler devices really aroused more enthusiasm than the complicated models, as their application was so simple and obvious. Thus in place of the usual square-headed set-screw used to hold a belt pulley on a shaft there was shown a screw without a head which by using a key wrench fitting in a square hole could be screwed in tight without leaving any projections to catch the workman's hand, as frequently happens with disastrous consequences. As loose nuts are the cause of so many accidents it was natural that several forms of safety bolts and nut-locking devices should be shown and their advantages demonstrated. A guard for the handles of wheelbarrows to protect the hands of the workman in passing through a passageway or past a post or pillar was so simple as to suggest surprise that it was not more used.

The deleterious effects of various dusts and vapors on the respiratory organs were shown by a series of anatomical models and preparations and specimens of the dusts themselves sent by Dr. Sommerfield of Berlin, the collection giving a complete and realistic representation of the effects of inhaling fine dusts, such as those of iron, emery, and stone, and poisonous vapors incident to various industrial occupations, as well as the results of other unsanitary occupations, such as match making, where the "phossy jaw" of the matchmaker or the poisoning of the leadworker was seen. In particular, the models showing the condition of the lungs of workmen forced to breathe such air were most impressive, especially when seen near the representation of the normal lung. But adjoining this collection were shown various respirators which could be worn as a protection by those forced to work amid dust, ammonia fumes, or smoke. With respirators must be considered smoke goggles for the eyes and smoke and ammonia helmets, various types of which were shown.

While typhoid fever is largely preventable in most communities by intelligent care for the water supply, yet a simple distilling apparatus, shown by the Forbes Company, is a most effective means of destroying pathogenic bacteria. Such an apparatus was exhibited which simply required connection with the gas and water supply and would thoroughly sterilize drinking-water, the device being particularly economical in its utilization of heat.

Just what form of elevator is the safest the exhibition committee in all probability would not pass on, but the Travellers' Insurance

Co. showed a collection of broken cables whose failure had resulted in fatal accidents. The remedy for this obviously is sufficient, expert, and regular inspection. Another frequent element of danger in connection with elevators is the door or hatchway which the carelessness of an operator may leave unprotected. This has afforded wide range for inventive skill and a number of such devices are shown, including those in which fireproofing is added.

If it is necessary to have elevator doors that shut, it is equally important to have for theatres and school houses doors that will open in an emergency, yet ordinarily will be locked. Samples were shown of such doors by the Standard Safety Window Guard and Exit Lock Door Co. Pressure on a broad plate or handle, either involuntary as by a pushing crowd or by a single person, draws the bolts and opens the door instantly.

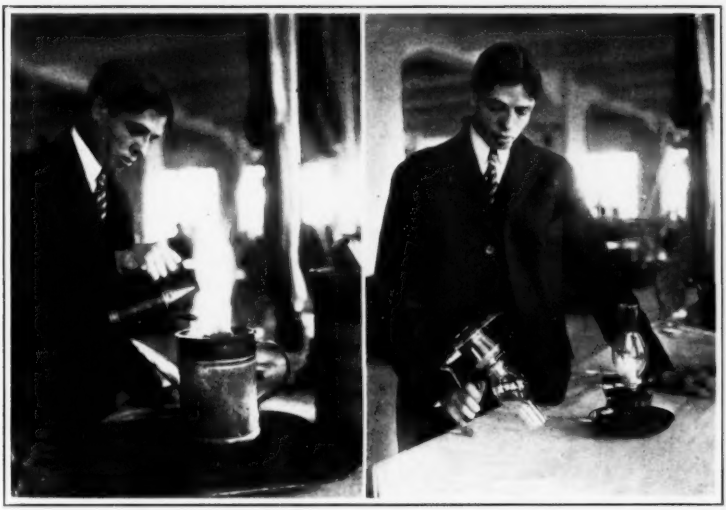
Outside of transportation it is quite probable that fire claims the largest number of victims of any single cause of accidental death in the United States, and in an exhibition of safety devices the various means of saving life in case of fire naturally appear prominently, varying from the life net to the fire extinguisher carried on the automobile. The various portable fire escapes once made of manilla rope now appear with chains or wire rope and broad metal treads for the special advantage of women. The usefulness of portable fire apparatus is emphasized at the exhibition, as a convenient local extinguisher is often sufficient to quench what might prove a blaze of large dimensions. Thus a nest of buckets supplied by the Safety Fire Extinguisher Co. is contained within a tank of chemical extinguishing fluid which neither evaporates nor freezes. If placed at convenient points about a factory or a steamship this is a satisfactory means of putting out an incipient fire that easily might prove troublesome. Still more effective is the portable chemical fire engine with its hose reel for country places and factories, which is shown by S. F. Hayward and Co., and for isolated places where a water supply under pressure is not available immediately, it is a valuable means of protection. Next on the list of fire-prevention apparatus comes the automatic sprinkler, a number of which made by the International Sprinkler Co. of Philadelphia were shown. With these are shown various forms of thermostats that immediately give an alarm of a dangerous temperature, as 175 degrees F. Of these a most simple form is the double conductor of the Montauk Fire Detecting Wire Co., where any undue increase in temperature causes a fusible metal coating of the inner conductor to break down the insulation, and thus forms a short circuit and communicates the alarm

THE ROYAL BAVARIAN INDUSTRIAL MUSEUM, MUNICH.
Halls of general hygiene and of safety building appliances.

FIRE-PROOFING AND FIRE-EXTINGUISHING DEVICES.

to the annunciator and gong. This device, like others shown, can be installed in any ordinary bell circuit. Or one can examine a new form of fire detector put out by the Rich Marine Fire Indicator for use on steamships, in which pipes from each compartment or hold are led to the pilot house, where a bell ringing every quarter of an hour warns the captain or watch officer to examine the outlet of each tube for smoke. These tubes all terminate in a compartment containing an electric exhaust fan which is constantly drawing the air from each hold through the tubes. Consequently, if there is fire in any compartment, it will be at once detected and connection can be made with the steam or water mains, and steam or water can be forced through the pipe directly to the particular compartment, while the alarm is being sounded. The great lesson for the American public to learn is that fires are preventable, but that the only emancipation can come by fireproof construction. Indeed, the loss of life and property involved in great conflagrations can be obviated by the more general use of concrete and fire brick, which with the increasing prices of wood is now available even for the simplest buildings and dwellings. In order to illustrate the desirability of such fireproof construction for buildings designed for workingmen, several apart-

ments thus built were shown at the exhibition, made of hollow fire-brick, reinforced with T bars laid between the courses, and it was explained that they possessed the advantage of being much cooler in summer and warmer in winter than the usual type of dwelling. The fire-proof door has for many years been deemed essential in warehouses and mercantile buildings. Now we learn from the Museum of Safety Devices that there are on the market fire-proof doors finished to represent wood and available for dwellings. Furthermore, these doors with their enamel finish are absolutely sanitary and offer no change for dirt or germs to lodge. Safety containing vessels for gasoline or naphtha are exhibited in which by means of gauze and suitable valves in the various containers the danger of explosion is reduced to a minimum. The Stillman Safety Lamp consists of a metal bowl or font with a false bottom and a vertical perforated wick chamber into which the oil passes from an intermediate space packed with wool and holding the oil in suspension.



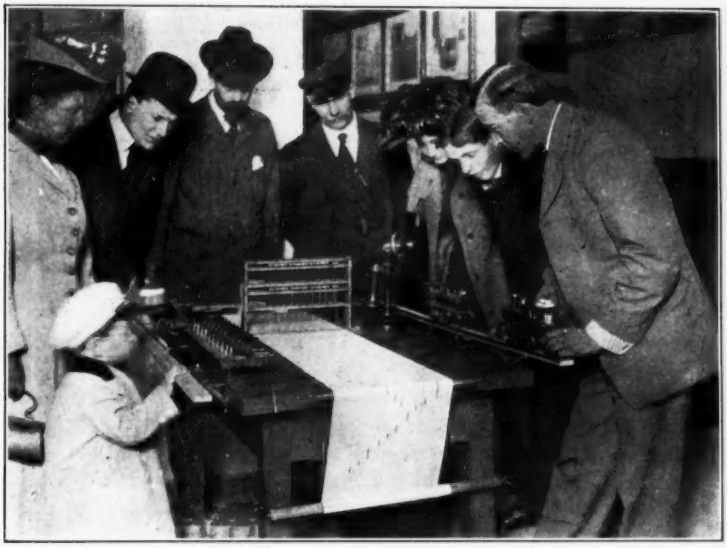
DEMONSTRATIONS OF THE SAFETY GASOLINE TANK AND KEROSENE LAMP.

With fire, as has been suggested, the American railway and the electric street car contribute most effectively to the needless mortality of the nation. If at this stage of American civilization and development we must consider the deadly grade crossing a necessity in well settled communities, then its proper and adequate protection should be demanded and sufficient notice of a train's approach should be

given to all crossing the tracks. At the exhibition is shown a model of track gates from the Automatic Gate and Crossing Co., which without any operator protect the crossing in addition to giving warning by bell and danger lights of the approach of a train within two miles. Next to grade crossings there is a large element of danger from collision in working a single-track high-speed trolley line. This can be prevented by various automatic signal devices, one of the most recent of which, the Nachod Automatic Signal, manufactured by the United States Engineering Co., figures in the exhibition. It automatically indicates the presence and direction of a car on a single track by lights and semaphores. The Simmen automatic railway signal is designed to protect automatically against accidents resulting from the errors of the engineer or dispatcher, and to eliminate the telegraph operator for reporting trains and delivery of train orders. It also provides for the automatic recording of the location of trains (in the dispatchers' office) as they advance along the track, and permits the dispatchers to signal direct to the engineers of the various trains in their cabs while the trains are in motion. If the engineer fails to obey the signal to stop, the air brake is automatically applied, the train is brought to a standstill, and direct telephone communication is established between the dispatcher and the engineer on his engine. The system is already installed on 18 miles of the Santa Fe in Southern California. The connection between efficiency of operation and safety is strikingly illustrated in the air brake shown by model, and it is indeed rare that the application of safety devices has any other effect than to improve the mechanical conditions of the machine or plant.

Previous to the adoption of automatic couplings there was a great number of accidents to men engaged in coupling railway cars. This the compulsory use of the automatic coupler has reduced, but still it is necessary for a man to crawl between the cars to join the air-brake hose, and there is a certain number of accidents due to this cause. The Cary Automatic Car and Train Pipe Coupler combines both operations by a simple device and as soon as the cars are joined both the cars themselves and the air-brake hose connection are instantly coupled.

The Dube railway spike has one side barbed or serrated in order to hold more firmly; this spike is driven with a companion key which forces the projecting points firmly into the wood, but which on being withdrawn permits the spike itself to be removed without damage either to it or to the tie.



THE SIMMEN AUTOMATIC RAILWAY SIGNAL EXHIBIT.

Rapid transit in cities as carried on to-day is fraught with many dangers, and to obviate these the American Suspension Railway Co. is prepared to install a system where the car is suspended from a double track on an elevated structure. For several years a suspended railway in Germany between Elberfeld and Barmen has been successfully operated without accident, and the new system, plans of which were exhibited at the exhibition, is claimed to have many improvements, chief of which is the suspension from a double instead of single track.

But transportation wherever it may be has its dangers, and in navigation there is a vast opportunity for safety devices, which become the more essential the more they are developed. Thus for the life gun, there is the Meyer and Rogers projectile, recently approved by the United States Government, consisting of a projectile terminating in a grapnel anchor, to which is made fast the end of a substantial rope, instead of the shot line to which a stout rope must be subsequently attached as in the ordinary life gun. This device, which with a pound charge of gunpowder will send a rope a distance of 1600 feet, is useful both in sending a line from ship to ship and from ship to shore, or vice versa, as the arms of the grapnel catch either in the rigging or sand and give a firm hold to the rope which is heavy so that a breeches buoy may be operated over it. The Welin

quadrant davit, whereby two men can swing the heaviest lifeboat clear in twenty seconds, is an example of a much needed device to launch a lifeboat in the shortest possible time and thus save life when time is the most important factor in effecting rescues. Furthermore, this lifeboat, after the disengaging gear is tripped, may shove off with all the crew in place and with far less danger of capsizing than in the older form of launching apparatus. The Engelhardt lifeboats which are collapsible, unsinkable, and self-bailing are approved and recommended by the U. S. Government, and three of the boats nested together occupy no more room than a single ordinary lifeboat. With this equipment every passenger steamer can carry, and should be made to carry, lifeboats for every person on board, and the U. S. Government regulations permit three of these boats to be carried under a single set of davits. A log indicator of the National Instrument Co. of Stockholm is a device of great assistance to the navigators as well as a provision of safety, for it records on a tape the number of miles logged, and if the course is to be changed at any time notifies the watch officer by ringing a bell after a given course has been sailed. Of different nature are the marine night and danger percussion and friction igniting signals of the Coston Signal Company for use either at sea or on railways, and their rockets both for signals and for carrying a line. Among these most interesting devices is the life buoy with signal attached, which when thrown overboard at night ignites automatically and burns in the water with a bright light, thus marking the buoy both for the swimmer and for the rescue party.

A very interesting exhibit is a model mine, shown by the Carnegie Steel Company, where the wood timbering has been replaced by steel as is now demanded by the best modern practice, on the score of safety on account of its greater strength, for its ease of application, and for the increased economy with the present high prices of wood. Likewise the miners' lamps, dating back to Humphry Davy, but to-day none the less essential not only for illumination but for the detection of mine gases are seen in improved form. One of the most readily prevented classes of accidents are those supplied by such machine tools as presses, punches, jointers, shapers and circular saws, where even skilled workmen are not exempt from danger of losing fingers or hands. But safety devices covering or protecting the saws and knives can be applied to these machines without impairing their efficiency, and there are shown in operation at the exhibition guards of the Jones Safety Device Company which most effectively protect the woodworker. Then there is a die punch where not

only is the hand of the operator protected, but the work is automatically removed from under the die. Likewise a circular saw where the blade is guarded and the wood is secured against striking back at the operator, while a protected jointer is shown with a jointed handle which is an important element of safety. A series of electrical and mechanical hoists as shown by the Yale and Towne Manufacturing Company appeared as safety devices.

It was also interesting to note from a collection of photographs that particular attention is being devoted to the subject of eliminating danger to employees in all of the new plants under construction for the United States Steel Corporation. For several years a commission has been investigating the question of preventable accidents in its various works, and as a result of their examinations, numerous safety devices have been installed in a number of the plants.

Cleaning the windows of a high office building involves considerable danger unless the cleaner has a suitable safety belt to protect him in case of his falling. These belts must be fastened to bolts so secured in the walls or window casing as to be absolutely firm. Several forms of such bolts to which the belt is fastened were shown, available for either brick walls or wooden window frames. The safety clothes line which prevents another form of window danger also figured in the exhibition.

One of the most effective safeguards of the health of a community is the protection of the milk supply, and the work now being done in this field by the Board of Health of New York City has been so favorably criticized that an important collection of photographs showing the range and methods of milk inspection was a notable feature of the exhibition. With typhoid fever and small pox as preventable or reducible diseases must be considered tuberculosis, and a tuberculosis camp for the treatment of those in the early stages of this disease was shown by models and photographs by the New York Branch of the National Red Cross Association. While the elimination of accidents is the object sought in the museum, yet this does not prevent the consideration of methods and apparatus for first aid to the injured. As an example of what should be done on a railway, an exhibit of the Pennsylvania Railroad includes the standard outfit of litter and first-aid packets with which every baggage car is equipped, together with the various instruction books issued to employees and photographs showing actual applications of the first aid. This company maintains for its employees regular courses of instruction given by its surgeons. It also assists a benefit association of employees providing for cases of injury or illness.

A COLLECTION OF PHOTOGRAPHS ILLUSTRATING THE CONTINENTAL MUSEUMS.

In connection with the exhibition there were awards of gold medals for the best safety devices in the field of transportation, mining, and motor vehicles and motor boats. These have been provided respectively by the *Scientific American,* the Travellers Insurance Company, and F. H. Richards, while prizes of $100 each have also been provided by Dr. L. L. Seaman for the best essay on "The Economic Waste Due to Occupational Disease," and by Richard Watson Gilder, F. R. Low, and William H. Tolman, on "The Economic Waste Due to Accidents."

Both for the actual character and merit of the exhibits and for its suggestive lessons this beginning of an American Museum of Safety Devices has had a most positive value, and it would seem desirable that further and more ample resources should be forthcoming to enable it to continue its work adequately. As at least seventy-five per cent. of all accidents are preventable, and those that do occur can be relieved by proper first aid treatment, anything accomplished in this direction must be of great and lasting value.

OBTAINING ACTUAL KNOWLEDGE OF THE COSTS OF PRODUCTION.

By F. E. Webner.

II. WHEN AND WHERE A CLOSE KNOWLEDGE IS NEEDED.

BROADLY speaking, it may be truthfully said that every concern which pays dividends on its more or less narrow margin of profit from manufacture needs a close knowledge of production cost if the desire exists to maintain the dividend-paying basis, or perchance to increase the dividends or the surplus.

There are managers who are not in the least interested in costs and from their point of view one can quite agree with them. In the manufacture of new specialties which have proved to be winners to the extent of taxing the capacity of the management to its utmost to fill orders and take care of remittances, there is no pressing need for a close knowledge of detail costs; later on, when the inevitable "just as good as" appears and competition cuts into revenues, the subject of retrenching becomes live and factory costs are important.

When the buffalo roamed the plains in countless numbers they were often slaughtered merely for their tongues, to be used as counters to prove prowess. In similar manner have vast tracts of timber been frightfully abused and shamefully wasted that some slight need might be supplied, as for instance, the cutting of shakes in the early pioneer days. A shake formerly was a rude form of clapboard for building purposes, but has developed into a split shingle for making durable and artistic roofs. In early days shake-makers made camps in the sugar-pine belt and cut as they pleased, felling tree after tree in total ignorance of scientific principles underlying the proper choice. Only one tree in from six to ten sugar pines will split into shakes. The old pioneer way was to cut a tree down, saw a piece off, and try it; if it was useless for the purpose it was left to rot. The modern shake-maker chooses a mature sugar pine with thin homogeneous bark and "chips" it high up; he studies the "twist" and fiber until he is satisfied it will "work," and then he fells it; thus the resources of the timber tract are husbanded for use along other lines. The wastefulness of the past is being paid for in the present and will undoubtedly be more highly paid for in the future. The cost is there, to be absorbed somehow—and it must be absorbed; there is no alternative.

The parallel is drawn between the cases illustrated and the conditions surrounding the production of many public utilities and products, where a large degree of monopoly exists and the margin is sufficiently large in the mind of the management to preclude the necessity of finer distinctions and discriminations in the way of prime-cost lessening; so the public pays the freight and continues to smile and look as pleasant as possible.

There are cases where the consumer pays for existing evils over which the management can exert no possible influence. An instance in point is the making of fire-brick; the general run of labor is paid by piece work, and throughout the Southern Ohio fire-clay district there exists an unwritten law that certain quantities constitute a day's work, depending on the operation; even though such allotment of work may be finished at 2 P. M., no amount of coaxing, bribing, or driving will suffice to induce the laborers to perform more work, either of the same operation or a subsequent one; hence the volume of product of the individual works hinges on the whims and caprices of the labor element, and the selling price must be so fixed as to absorb the higher rate of expense burden imposed by the curtailed product.

It is a prevalent impression that where labor is on a piece-work basis or on what is known as the contract system, costs are known definitely. That is a serious mistake, which should be corrected as soon as possible in the minds of those who seek the truth. The case of the fire-brick manufacturer is a very good example. The piece workers may dally along all day with a small output and the consumption of an increased rate of burden of overhead expense, or again they may, and often do, take spurts and clean up in a short space of time, thus making it possible to save in power and other costs which are not fixed in amount but which accrue as used. It is a well-known fact that piece workers work spasmodically, and very often produce much less than their maximum capacity in order that the rate per unit be not reduced on them. Time consumed on piece work is, and should be, a part of the records of any well organized cost system. The premium system, whereby premiums and penalties are affixed for operations of various character, does more to stimulate the workmen to increased activity and energy than any other plan of payment under the ordinary run of conditions obtaining in modern shop practice. The secret is that the men share more liberally in the benefits derived than under the ordinary piece-work system, and when they come to a full realization of what it means are more keen to take advantage of it. The great saving in costs is made through the decreased burden of overhead expense, and through the increased

volume of output, which means ultimately one and the same thing. The single item of saving through the labor costs would not make the plan an attractive one, for the reason that the labor costs as such are increased rather than decreased.

The factory which produces but one article or one line of articles in different sizes needs to know its cost of production just as accurately as that factory which produces a hundred different articles; however, the costs of the former are naturally more simple to evolve than those of the latter, though that does not always follow.

There are scarcely any two lines of production which are precisely alike in so far as cost finding is concerned; a difficult cost proposition is that of the manufacturing of optical goods, where in the grinding of lenses flaws are not discernible until after the lens has been practically completed and polished; it frequently happens that an eye-glass lens priced at one dollar will cost four dollars to grind, by reason of the several lenses that may have to be ground before a perfect one is produced. Possibly there may be a second- or third-grade outlet for the lenses condemned as first-class, and again possibly they may be absolutely worthless. This waste constitutes the larger percentage of burden in this particular work, and a cost system is needed in a plant of this character just as much as it is needed in a machine shop; but most emphatically the plans evolved for the machine shop will not fit the lens-grinding proposition.

Without question the greatest need for a well equipped cost department exists in plants where staple articles are produced, where to a more or less large extent the selling price is fixed by competition.

Hog-packing industries are good examples of this class, and are also good examples of what can be accomplished by counting the cost and making the best of little items that to the casual observer would be thought of as waste. It has been well said that nothing about the hog except the squeal, escapes a profit-making use. To the reader's mind may come the question as to what relationship that bears to a cost system. It bears a close relationship. The bookkeeper records receipts and disbursements of cash, also purchases of material and sales of product; periodically a statement is laid before the manager, and with an accurate reflection of his affairs he is enabled to direct his interests intelligently and know where gains are made and losses sustained. A cost system presents but another phase of the same business, and incidentally to its operation it discloses many leaks and drips which sap profits; it gives an accurate reflection of conditions, and if the management does not embrace all the opportunity afforded, then it is not getting full benefit. The cost system

does not operate physically to cut down the cost of product—it presents apparent needs just as soap floats and makes a mute appeal for assistance. The general books present certain possible needs of retrenchment as between the factory and the outside world; the cost books present certain needs of retrenchment within its own confines.

A cost system is not a fad any more than astronomy is, but a serious proposition representing an original outlay of money and the retention of someone who knows his business in order to make the investment pay. The manufacturer may come to a point where he makes up his mind to indulge in a cost system. His probable needs are greater than he realizes, yet like buying needed life insurance, if he has not a strong influence brought to bear upon him constantly urging him on, he will invariably weaken in his determination through the machinations of disgruntled employees who cite many fancied wrongs as bugaboos against any change in plan. In the installation of a cost system it is a foregone conclusion that some points in the plan are bound to need revision according to developments, and if the manager be one who is easily discouraged he would better delegate to a strong-willed and enthusiastic subordinate the authority to proceed with the work, and then himself keep hands off and look only for results. As a broad rule, the greatest need exists for a cost system in plants where the labor element is diametrically opposed to it, as it means a curtailment of privileges formerly enjoyed and usually costly to the concern both directly and indirectly.

Under some conditions the refusal of foremen or workmen to do certain things required of them will seem to make it impossible to proceed with an installation; such conditions will have to be specifically treated, but in a number of cases which have come under my personal notice the dismissal of otherwise seemingly good foremen has had a salutary effect upon those concerned. A foreman is not what might be called "good" if he persistently works at cross purposes with the management.

Where a factory plant has grown from a small beginning to a large and distorted array of lean-tos and additions, and the route of the product in its course of process through the factory is physically cumbersome, then a cost system will be just as cumbersome and will show results which the management will refute. In cases of this kind the manager usually confesses to a knowledge of high costs but is not in position to know exact results, and he doubts the real truth.

In conclusion, the modern factory and the ancient one both need a knowledge of costs; but no cure-all remedy can be applied to each in the same manner—careful and specific treatment is needed.

A FOUR-YEARS COURSE IN INDUSTRIAL ENGINEERING.

By Hugo Diemer.

THE ENGINEERING MAGAZINE has long urged that modern conditions of engineering employment demanded modifications in the scheme of engineering education. In the words of a writer reviewed in our March issue, many of the subjects included in the standard courses have not been taught as they must be practiced, and the entire scheme needs to be brought closer to life. Especially has provision been lacking for the large proportion of engineering graduates whose future work lies in the intelligent, efficient direction of manufacturing operations.

It is most gratifying to find that two of the great American Universities—Columbia and Harvard—are undertaking to solve the problem, one from the engineering and the other from the economic side. This notable movement, and the present season of special interest in the college year, make this article by Professor Diemer, of the Pennsylvania State College, peculiarly timely. It is a concrete presentation of a proposal for a course preparing the student for industrial work, and merits the attention due to pioneer effort. Next month Professor Rautenstrauch, of Columbia, will discuss the plan here outlined and will give the added interest of another advanced viewpoint.—THE EDITORS.

SINCE the introduction of manual training into public schools there has been considerable argument whether a school education is to prepare the student to make a living, or whether it is to prepare him for life. Evidently he must be prepared for both.

It is becoming more and more generally recognized that manual training may well be given a place for its cultural value and that for this reason it may with advantage be given to all classes of pupils in the elementary schools. It is also becoming just as generally recognized that manual training as taught in the general cultural school cannot take the place of vocational industrial education.

The low efficiency of the craftsmen in various trades in America is becoming a cause of concern not only to employers and owners of industries, but to the leaders of organized labor as well. The tendency toward specialization makes it well-nigh impossible for apprentices to get a good general knowledge of their trade such as was in former years quite possible. In his striving for variety of experience, the young tradesman is perforce compelled to adopt a nomadic life, changing jobs and places of residence,—a process that not many can follow advantageously.

It has been noted and commented on that tradesmen coming to the United States from Germany are better all-around workers in

their craft than the average of Americans in the same occupation. The German "continuation" schools, or trades schools, are largely responsible for this superiority. The Germans compel all children to attend the general-culture schools until they reach the age of fourteen years. In the general-culture schools they also receive manual-training exercises intended for general education. In the "continuation" schools the instruction is by skilled tradesmen, and in them one may learn to be a brick-layer, a plasterer, a carpenter, a lock-smith, a painter, a motor-man, and so on, receiving a thorough two-years trade-school training by experts in the trade.

We need a similar system of vocational schools in America in which we may prepare our young workingmen to be better workers, to be more skilful and less wasteful. The protestations of Mr. Crane of Chicago are not without reason, in that he like many others sees disadvantages in too great expenditure on higher technical education with no corresponding outlay in trade training for those who cannot attend the public schools longer than their fourteenth year.

Hand-in-hand with the secondary school system we need a further more advanced class of vocational schools for such students as have completed their general-culture high-school course at the age of eighteen and wish to spend not over two years in becoming proficient in one of the more advanced trades. In this second class of trade schools there could be taught such occupations as lithography, printing and other crafts of higher order. Such vocational training would not need to interfere with the sort of manual training which is now given in high schools and which should be continued as general cultural education. Such manual training should be given students in all courses so that they may have trained eyes and hands and may know the elements of wood and metal working, of domestic science, and of the arts and crafts in general.

Having thus provided for those students who cannot go to school beyond the periods of primary or secondary education respectively, by giving them an opportunity in separate schools, to gain vocational training also, we can keep our general primary and secondary school curricula free from vocational studies and can devote them wholly to the work that will best prepare for citizenship and for life in its broadest sense, and can retain still a section in our secondary schools for such preparatory studies as are needed by those students proposing to take a college course.

At first sight it would appear that we might continue this simple system into the realm of higher education, offering a four-years

course in arts to those who could continue their general cultural education to the age of twenty-two, and then offering a vocational technical course to the graduate from the school of arts, or "college."

There are relatively few students who take first a course in arts and then follow it by a technical course, and the larger proportion of these few are those who take up the study of law or medicine. In engineering it is important that a continuous line of training be unbroken, and the consequence has been that we have tried to establish in our engineering courses a certain degree of general cultural training. Yet the more specialized technical portions of the engineering courses demand practically all the student's time, so that he cannot spend much effort on general culture, and the result is that after four-years time almost all the emphasis has been on technical specialization, and little if any time has been devoted towards training for life and citizenship.

To be sure, the greatest demand made on engineering schools thus far by students, their parents, and their employers, has been for technical specialists, and the need will always exist for four-year courses which are extremely specialized technically and which prepare the graduates to become chief chemists, head electricians, chief draftsmen, and designers. But there is also a need for men so trained that they can be developed to fill positions in industrial management in such a manner that they are serving the interests of all concerned, namely the purchasers, the men employed in the industry, and the small as well as the large stockholders. America was never more in need of men trained for industrial leadership than she is today. Her industries are suffering on account of the lack of such men—men who are not only thoroughly familar with productive processes, but who have broad human interests and are at the same time thorough business men.

Hitherto courses for educating mechanical engineers have concerned themselves primarily with the processes of designing and testing. The existing courses are admirably adapted to fit men for these processes. The manufacturing industries, however, are in need of men who know how to produce more economically. As America's natural resources diminish and approach more nearly those of foreign competitors, she is compelled to be less wasteful in manufacturing processes. Moreover, she must look for foreign trade to a much greater extent than hitherto.

In the past so large a proportion of the technical graduates have found employment in the large electrical and engineering corporations

that the smaller industries of America have not availed themselves of the services of technically trained men to any considerable extent. Yet the most wasteful power plants, the most inefficient manufacturing processes, the most uneconomical building arrangements, and poorest organization methods, are found in the smaller industries. The opportunity for much greater profit and greater comfort to employees as well as greater peace of mind to the owners exists here. The owners of the smaller industries should appreciate the fact that technically trained men can be employed in many cases at not much higher wages than must be paid for men without such special training, who cannot develop with a growing business as well as the technically trained young man can.

A young graduate, no matter what his course of study has been, will of course not be able to revolutionize matters shortly after his employment in such an industry. Yet he should be able to save his wages many times over from the very beginning if he has been properly educated. On the other hand, the young technical graduates should be more willing to put up with the greater disadvantages they would at first encounter in entering the employ of smaller industries instead of the larger corporations. Life during the first few years of one's experience as an employee of the large corporation is apt to be more pleasant on account of social contact with other young college graduates, than would be his experience as an employee of a small industrial establishment, but in the long run his chances for independence and leadership are greater in the smaller establishment. Yet the possibility of leadership has been overlooked in the strictly technical curricula. The true function of the technical school of college grade should be to develop not only technical specialists, but superintendents, managers, and leaders in general.

The relative proportion of technical-college graduates to the number of graduates from secondary and primary schools is so small that we can legitimately adapt our technical-college courses to prepare their graduates to fill the higher places. If we adopt this policy for the higher schools, then we must provide for vocational technical schools for the graduates from primary and secondary general-culture schools. When we have once provided these vocational schools, the place and aim of the college technical school will be unquestioned. It must train for leadership.

Now that all America is pausing and trying to find the causes of the sudden financial and industrial depression, we are beginning to realize that we have been wasteful and inefficient in our manufactur-

ing and construction processes, and that too often endeavor has been made to conceal this wastefulness by skilfully complex business statements, and to cover it up by sales of new stock, bonds, and other securities. We are beginning to realize that we must become more economical and more efficient in our manufacturing processes and business methods, and that we must know enough about accountants' and auditors' statements to know exactly what they do mean. One of the natural results of this present depression will be a demand for men who can make industrial enterprises really pay—not only on paper, but actually and permanently. We need to educate men to meet this demand.

The men we must provide must be trained in three distinct lines. They must be thoroughly grounded in engineering. They must have creative ability in applying good statistical, accounting, and "system" methods to production; and, finally, they must know something about men, so that they may develop in themselves the ability to stimulate ambition, and know how to exercise discipline with firmness and at the same time with sufficient kindness to insure the good-will and co-operation of all. The more thoroughly the graduate of a course intended for leadership is versed in questions of practical economics and sociology, the better prepared will he be to meet the problems that will daily confront him.

In such a course, education in commerce, statistics, and economics and sociology should go hand-in-hand with engineering education. As at present constituted, our college courses permit such training only for the students taking a college course in arts first and an engineering course afterwards, or *vice versa*—a procedure which very few follow. It is possible, however, to co-ordinate the essentials, as above enumerated, in a special four-years course.

By comparing the courses in mechanical engineering as now given in a number of representative American engineering schools, it will be seen that the amount of time devoted to any one branch and to groups of allied branches differs widely, so that if one will take the average time devoted to engineering fundamentals in these schools, and then note the minimum time devoted to these same fundamentals by certain successful institutions, it appears that without even confining one's self to the minimum times, a schedule of fundamentals in engineering could be laid out that would still leave available a considerable part of the four-years course for those branches which would train the graduate for industrial management.

The chart on pages 354-355 shows the relative times devoted to

COMPARISON OF MECHANICAL-ENGINEERING COURSES.

	Lang		Hist. & Econ		Gen. Elective	Mathematics					Physics				Chemistry		Drawing		Shops						Mach. Des.				
	English	Mod. Languages	History	Political Science		Trigonometry	Algebra	Analysis	Calculus	Diff. Equations	Elec. & Magnetism	Heat	Light & Sound	Phys. Laboratory	Gen. Chem.	Analytic	Free Hand	Geom. & Projections	Shop Methods	Forging	Carp. & Wood-Turn.	Pattern Making	Foundry	Machine & Bench	Mech. of Mach.	Mach. Draw. & Des.	Steam Eng. Des. (R.)	Pneu. Mach.	Photography
Penn. State	10	12½	6	8		5	3	5	7		4	2		1	4½	5½	1	2½	3		2½	3½	1½	1	3½	8	12	2	2	
Percentage	**12.7**		**8.2**				**11.7**					**4.1**			**5.7**		**3.8**				**7**					**14**			
Cornell					2			5	5		6	6			6	5		3	2	1	2		4	2	4	8	15	6	2	
Percentage					**1.4**			**7.1**				**8.5**			**7.8**			**3.6**				**9.2**					**22**			
M.I.T. †	170	710	100	90	120	90		90	180	270	90	135	35	135	100	195	165	45	90	135	110	60	30	30	220	330	368			
Percentage	**12.3**		**3.3**		**2.1**		**12.5**					**7.**			**6.2**			**4.7**				**7.8**					**12.1**			
Purdue	10	10	3	3		5	5	4	10			12			4	2		6	6			18			7	10	2			
Percentage	**11.8**		**3.5**				**14.2**					**7.1**			**3.6**			**7.1**				**13.6**					**11.2**			
Michigan	4	16					4	4	8			5	5	3	4	4			4		4		4		4	4	15			
Percentage	**14.3**						**11.4**					**9.3**			**5.7**			**2.9**				**8.6**					**13.6**			
Illinois	14		4			2	3	5	8			5		4	4			4	4			6		5	8	11				
Percentage	**16.2**		**2.9**				**13.2**					**6.6**			**2.9**			**5.8**				**8.**					**13.9**			
Iowa State	10	6	8	5		5	5	5	5		6	2	2	5	11	5		2	2			14			3	11	3			
Percentage	**9.1**		**7.4**				**11.4**					**8.5**			**9.1**			**2.3**				**8**					**9.7**			
Wisconsin	6	11				5	5	5	5			10			6			6	3	4	2			6	4	14	6			
Percentage	**10.6**						**12.5**					**6.3**			**3.8**			**5.6**				**7.5**					**15.**			
Ohio State	12	12				5	5	5	15	1	3	3	3	5	10	4	4	6	6	3	3	3	2	7	7	18			2	
Percentage	**10.8**						**14.**					**6.3**			**6.3**			**7.2**				**8.1**					**12.2**			
Cincinnati	6					4		4	8			4	4	4	6	4	2		3	3	6			6	4	15	5	2		
Percentage	**4.2**						**11.1**					**8.3**			**7.**			**3.5**				**10.4**					**18.**			
Worcester †	18	39		18		9	12	15	15		12	15		10	16	8	6	4	9		6½		8	6½	24	9	29			
Percentage	**13.2**		**4.2**		**0**		**11.8**					**8.6**			**5.6**			**4.4**				**10.4**					**8.8**			
Columbia				6		2		6	5			8		3	14	10½		8	3	2		10½			6	18	10	2		
Percentage			**3**				**6.5**					**5.5**			**12.7**			**5.5**				**6.2**					**17.9**			
Average Percentage	**9.2**		**2.7**		**.3**	**11.5**					**7.2**				**6.4**		**4.7**		**8.7**						**14.**				
Highest Percentage	**14.3**		**8.2**		**2.1**	**14.2**					**9.3**				**12.9**		**7.2**		**13.6**						**22.**				
Lowest Percentage	**0**		**0**		**0**	**6.6**					**4.1**				**2.9**		**2.3**		**6.3**						**8.8**				
Proposed Percentage	**13**		**30**		**0**	**12**					**4**				**7**		**4**		**4**						**2**				

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† These institutions use a system of values different from the others, as explained in the text.

COMPARISON OF MECHANICAL-ENGINEERING COURSES.

Mechanics			Metallurgy	El. Eng.				Civil Eng.						Architecture	Mechanical Engineering												Eng'g. Elective	Gymnasium	Military		Religious Practicum	Total
Elem. of Anal. Mechanics	App'd Mech.	Eng. Materials		Dynamos	Electr. Trans.	Electr. Lab.	A. C. Machinery	Hydraulics	Hyd. Machinery	Masonry	Graphic Statics	Surveying	Structures		Steam Eng. & Boilers	Thermodynamics & Heat Engines	Heat & Ventilation	Locomotives	Contracts	Shop Economy	Thesis	Seminary	Other Work	Steam Lab.	Mfg. Plant Power Plant			Tactics	Drill		"Semester Hours"
3	5	2½	1	2	2	3		2	2	1½					3	10	2	2	1	1	6½			6			1		½	171½
	6.1		0.6		4.1					3.2										18.2							0.6			
5	5	2		4		4		2							4	7				2	8			10		3	1	12 Act.-Hrs.	½	141
	8.5				5.7					1.4										22						2.1	.7			
90	135		30	45	60	45		45	90	45		15	135		135	135	15		30	30	120			202		225	90		½³	5785
	6.2		.5		2.6					5.7										11.5						3.9	1.6			
4	3	1	2	3				3		3					4	5	2	4			4			8			1	12 Act.-Hrs.	½	169
	4.7		1.2		1.8					3.6										16.							.6			
5	5		2	3				4					1	3	4	3			3					5		10				140
	7.2		1.4		2.1					3.6				2.1						10.7						7.2				
5½	3½	1		2		2		3			5	2			4	5			1		3	4		6			2	1	½	137
	7.3				2.9					7.3										16.8						1.5	.7	12 Act.-Hrs.		
3	8	3		2	2			4	3							3		2	1	2	6	4	4	6			8		½	176
	8.				2.3					4.										15.9							4.5			
3	8	3		3		4	3	3	3						5	5			1		14			4		3			½	160
	8.7				6.3					3.7										18.1						1.9				
5	5	2	5	4		4		5	3	3	5				10	5				3	5			14					½	222(8⅓)
	5.4		2.2		3.6					7.2										16.7										
2	7		6	3	6	1	2	3	3						4	10					3			4					¼a½	144
	6.2		4.2		8.3					4.2										14.6										
12	18	3	0	6		8	6	9			4				9	18			3	8	12	3		23		0	0	0		¾	431
	7.7				4.6					3.0										17.6										
5	8		2		12	3		4½				2	1½		6	13				2		1	5	10	9½		2		½	201½
	6.5		1.		7.5					4.										23.1							1			
6.9		.9		4.3				4.2						0.2	16.8											1.3	.2				154.*
8.7		4.2		8·3				7.3						2.1	23.1											7.2	1.5				197.5
4.7		0		1.8				1.4						0	10.7											0	0				137.
7		–		1				5						3	8											0	0				169

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* All totals were reduced to a "semester-hour" basis before the averages were computed.

various branches by twelve representative American schools in their course in mechanical engineering.

The unit of time devoted to any one subject or group of subjects is the "semester-hour" or "semester-period," being the equivalent of one hour of recitation work per week for one semester or half-year. Thus, in a class which meets three times a week for recitations in a branch which continues for one semester, the credit would be three periods. The column headed Recitation—Practicum, Relative Value, refers to the relative value assigned by the different schools to one hour of recitation as compared to one hour of practicum—viz., laboratory or drafting room or shop. Thus 1/3 would indicate that three hours of practicum work are required for a unit credit.

In the case of Worcester Polytechnic Institute the upper series of figures express the units as used at that institution, which differ from the notation just indicated in that they give the unit of value to one hour per week for one semester of practicum work, and each hour of recitation or iecture attendance is considered as requiring two additional hours of outside work, and the latter are thus given a credit of three units. The lower set of figures opposite Worcester are however reduced to percentage of total credit.

The system at the Massachusetts Institute of Technology is similar, but there the total hours which a man spends in class, shop, and preparation are counted. Thus a recitation coming one hour per week for a semester of, say, sixteen weeks, would receive a credit of the recitation hours plus the preparation hours multiplied by the number of weeks, or one hour recitation plus two hours preparation (viz., three hours) multiplied by sixteen, or forty-eight units credit. The upper figures opposite "M. I. T." are expressed in the units used at that institution. The lower figures are reduced to percentage of total credit.

As the Ohio State University has three semesters or terms per annum, the credits must be multiplied by 2/3 to give their equivalent value.

There is room for some difference of opinion as to the title of the group heading under which certain branches are listed in the classification. Thus under "Civil Engineering" are listed the branches of Hydraulics, Hydraulic Machinery, Masonry, Graphical Statics, Surveying, and Structures. This group is intended to cover the branches taught students in a mechanical-engineering course by instructors generally designated as instructors in "Civil Engineering." Continuing this particular group as an illustration, it will be noticed that the average number of semester hours of these various branches in the

civil-engineering group taught to students taking a mechanical-engineering course is 4.2; the highest is 7.3 and the lowest 1.4.

The writer is indebted to Mr. E. B. Norris, secretary of the schedule committee at Pennsylvania State College, for assistance in preparing this tabulation.

From time to time speakers at educational conventions have advocated the giving of instruction in branches that would train a technical graduate for management. These speakers have always been met by the argument that the engineering courses are already overcrowded. An investigation of the subjects taught at these ten representative institutions reveals the fact however that there is wide variation in the time devoted to any one subject. Evidently, a course in which the minimum time given by any representative school to a given purely engineering essential was used as the basis would be too light. However, a course can be prepared in which the essentials, such as mathematics, mechanics, and other fundamentals, are fully as strong in time as the average, and in which are omitted such courses as are not common to all. This would leave opportunity for insertion of the cultural studies. Such a four-years course is presented below.

It will be noted that at the very beginning branches are inserted which awaken the student's realization of the fact that human affairs constitute a most important part of life's work. Beginning with history in the freshman year, elements of political economy follow in the sophomore year, and more advanced courses in modern economics follow in each semester throughout the course. Accounting and business law and allied courses begin in the sophomore year, and accompany the work in economics in each semester following.

The regular mathematics of the engineering courses predominate, and are followed by kinematics, mechanics, and theory of structures. The fundamentals in judging materials are furnished in chemistry, qualitative and quantitative, engineering materials, metallurgy, and physics. Thus the student gets the really fundamental studies in engineering, omitting the descriptive and specialized technical branches.

In order that well-designed, safe, livable and attractive buildings shall appeal to the graduate, and that he may realize the effects of good buildings on economical production, he is taught graphics of structures, heating and ventilating, architectural drawing, and history of architecture.

The regular shop-work of the engineering courses is given, not quite so much time being devoted to this as in the mechanical-engineering courses. Sufficient steam- and electrical-laboratory work is given to familiarize the graduate with the elements of power-plant

work. Such a course is believed to be far superior to the so-called business or commercial courses offered by a few of our larger universities at present, since the latter courses are deficient in omitting mathematics and engineering, thus only partially equipping the graduate and being themselves open to the same criticism as to one-sidedness that can be made of purely engineering courses.

COURSE IN INDUSTRIAL ENGINEERING.

Freshman Year. First Semester.

	Actual Hours.	Credit Hours.
English	5	5
Mathematics (Trigonometry)	5	5
Modern Languages	5	5
History	4	4
Drawing, Freehand and Geometric	4	2
Forensics	1	½
	24	21½

Second Semester.

Mathematics (Analytical)	5	5
Modern Languages	5	5
English	2	2
History	4	4
Drawing, Projection	4	2
Shop Work	4	2
Forensics	1	½
	25	20½

Sophomore Year. First Semester.

	Actual Hours.	Credit Hours.
Elements of Political Economy	4	4
Elements of Accounting	3	3
Commercial Law	2	2
Mechanics (Elementary)	3	3
Mathematics { Algebra 3 / Calculus 2 }	5	5
Descriptive Geometry	6	3
French or German Conversation	2	1
English	1	½
	26	21½

Second Semester.

Political Economy	4	4
Mathematics (Calculus)	5	5
Commercial Law	2	2
Statistics	3	3
Physics	3	3
Physics Lab.	2	1
Shops	4	2
French or German Conversation	2	1
English	1	½
	26	21½

JUNIOR YEAR. FIRST SEMESTER.

	Actual Hours.	Credit Hours.
Commercial Geography	3	3
Theory and History of Money	2	2
Physics (Heat)	2	2
Steam Engines and Boilers	3	3
Mechanics (Analytics)	5	5
Shop Work	4	2
Shop Methods	1	1
Electrical Measurements	4	2
Steam Laboratory	2	1
English	1	½
	27	21½

SECOND SEMESTER.

Banking	2	2
History of Development of Industrial Society	3	3
Manufactures of United States	3	3
Machine Drawing	4	2
Theory of Structures	2	2
Graphics of Structures	2	1
Chemistry	5	4
Chemistry, Qualitative Analysis	6	3
English	1	½
	28	20½

SENIOR YEAR. FIRST SEMESTER.

	Actual Hours.	Credit Hours.
Industrial and Social History of the United States	3	3
Transportation	2	2
Corporations	2	2
Gas Engines, Refrigeration and Turbines	5	5
Kinematics	2	2
Qualitative Chemical Analysis	4	2
Bridges and Roofs (Str. 3)	3	3
Structural Design (Str. 4)	4	2
	25	21

SECOND SEMESTER.

Factory Organization and Administration	3	3
Engineering Specifications	2	1
Heating and Ventilating	2	2
History of Architecture	3	3
Architectural Drawing	4	2
Quantitative Chemical Analysis	6	3
Engineering Materials (1-3) / Metallurgy of Engineering Materials (2-0)	3	3
Thesis	6	3
	29	20

Summarizing the proposed course by groups of studies, we have:

Group of Subjects.	Actual Semester Hours.	Credit Hours.
English	13	10
Modern-Language	14	12
History	8	8
Economics, Accounting, and Jurisprudence	43	43
Mathematics	20	20
Physics	7	6
Chemistry	21	12
Drawing	14	7
Shops	13	7
Mechanics	11	11
Structures	11	8
Architecture	7	5
Machine Drawing and Kinematics	6	4
Mechanical Engineering, including Steam and Electrical Laboratory	22	16
	210	169

Expressing this in the nearest even percentage, omitting fractions, for comparison with the courses already established, we find the following results:

Group of Subjects.	12 Representative Courses.	Proposed Course.
English and Modern Languages	9	13
History, Political Science, Jurisprudence, and Accounting	3	30
Mathematics	12	12
Physics	7	4
Chemistry	6	7
Drawing	5	4
Shops	9	4
Mechanics	7	7
Civil Engineering	4	5
Architecture	Negligible.	3
Machine Design	14	2
Electrical Engineering	4	1
Mechanical Engineering	17	8
Miscellaneous, including General Elective, Engineering Electives, Metallurgy, and Gymnasium	3	0
Total	100	100

The foregoing comparison of the proposed course in industrial engineering with the average of twelve representative courses in mechanical engineering, brings out the following contrasts:

1.—In English and modern languages the proposed course provides for 13 per cent of credits against an average of 9 per cent. Most observers will admit that the engineer who is to become a manager must have a better command of language than has hitherto been the rule with technical graduates.

2.—The group of History, Political Science, Jurisprudence and Accounting, is raised to 30 per cent in the proposed course from an average of 3 per cent in present mechanical-engineering courses. It is believed this heavy increase is justifiable and necessary in order to produce men who can become practical, successful business men, and to reduce the number of business failures, without any weakening of the fundamentals in engineering.

3.—The Mathematics of the proposed course aggregate 12 per cent, identical with the existing average.

4.—The Physics of the proposed course has been reduced to 4 per cent from an average of 7 per cent in existing courses. It is believed that the higher mathematical physics of wave-motion may be omitted in this course.

5.—The Chemistry percentage in the proposed course is 7, as against an average of 6 per cent. The coming business man needs to know more about the composition of the materials with which he is dealing than has hitherto been the case, and chemistry stopping short of quantitative analysis is not sufficient.

6.—Drawing, including projection, mechanical drawing and descriptive geometry, has been reduced from 5 to 4 per cent. The student, however, has occasion to use his drawing instruments in his subsequent courses in structures and architectural drawing and in kinematics.

7.—The percentage of shop work is reduced to 4 per cent in the proposed course, from an average of 9 per cent. The reason for this is that the institution undertaking to teach engineering should not be a manual-training school. The kind of instruction in shop work that will be of real value to the industrial engineer is of a totally different character from that which has been heretofore given, and it will not require so much time. I wish to quote briefly from the outline of the course in Principles of Machine Manufacture as scheduled by Columbia University for the coming year.

"The Economic Elements of Shop Processes. Time and power per unit of surface finished or cut, and per unit of metal removed, with the conditions for most economic production. Processes in the shop. Functional operation of engine lathes, turret lathes, and automatic machinery, and limits of economic production by each process. Times of setting, handling, forming and finishing of parts for job and repetitive work in quantity. Limits of time, power, and cost for finishing surfaces per square inch and removing per cubic

inch and per pound by hand and machine operations. Machines for performing specific operations, their functional operation, capacities, adaptability and rate of production. * * * * Value of limit gauges, standard and special; measuring devices and methods of inspection. Selection of economic cutting conditions, and analysis of recent experiments on relations between rate of feed, depth of cut, heat treatment, form of tool, quality of the metal being cut, diameter of work, elasticity of work and tool; time of cut and cooling during cutting on the maximum allowable cutting speed. Adaptation of economic cutting speeds to machine tools as affected by the pulley and feeding power of the machine. Labor saving devices in the pattern shop. Tools and appliances used, capacity and adaptability, * * * * etc."

8.—Mechanics in the proposed course occupies 7 per cent, the same as the average.

9.—Civil-Engineering branches in the proposed course occupy 5 per cent, as against an average of 4 per cent, the increase being due to emphasis being laid on the graphics of structures in the proposed course.

10.—Architecture occupies 3 per cent in the proposed course, as against an imperceptible percentage in the average. The industrial engineer needs to use better judgment in erecting new plants and plant extensions than has been the rule in the past, and elementary architecture is desirable among the branches to be taught him.

11.—Machine Design in the proposed course has been reduced to 2 per cent from an average of 14 per cent. This is the heaviest cut, and is made for the reason that almost all competent machine designers unite in stating that if a technical graduate is thoroughly grounded in mechanics, kinematics, and strength of materials, and knows how to handle his instruments, his training is sufficient. When the technical graduate goes to work in a drafting room he must learn the special conditions there existing, and a thorough knowledge of the above fundamentals is more essential than much time spent in detailing in his educational course.

12.—Electrical Engineering has 1 per cent in the proposed course, as against an average of 4 per cent. The industrial engineer needs more to know about the selection of the right kind of apparatus and the essentials of direct-current and three-phase alternating-current installations than about the mathematics of alternating currents.

13.—"Mechanical Engineering" in the proposed course fills 8 per cent as against an average of 17 per cent, due to the omission of technical thermodynamics and analytical heat-engine tests.

THE PRODUCT AND METHODS OF EUROPEAN LOCOMOTIVE WORKS.

By Charles R. King.

Mr. King's review is devoted to the most actively interesting phases of European locomotive work, as shown in mechanical design, steam practice, and shop methods and devices. In this number he deals with German works and their product. A following section will cover French, British, Italian, and north European types, and will also give very interesting data concerning the oxy-hydrogen and other new processes of welding.—THE EDITORS.

WRITING in these pages upon European locomotive construction, in the year 1902, I commented upon the rapid increase ever progressing in the power of locomotive engines. During the last five years the development of the power per unit has been unceasing, and despite the prophesies made then, as now, to the effect that the locomotive engine is destined to be superseded before long by another form of power for railways, there appears every probability that it will respond to all requirements for long-distance traffic for a great number of years to come, and survive at least the present generation. Very frequent has been the fear expressed that it was already outgrowing the constructive gauges of the railways for which it is built; but the difficulty appears to vanish before the resources of actual practice. England with its smallest constructive gauge in Europe was to be, by all appearances, the first country to be faced with the impossibility of building larger locomotives; yet here, in the beginning of 1908, we have the English Great Western introducing the most powerful locomotives for express trains ever built on this side of the Atlantic. The fact is a remarkable one, and edifying for Continental locomotive builders. The locomotive with a boiler of over 3,400 square feet of heating surface, producing steam with a tension of 225 pounds and a temperature of 130 degrees F. above saturation, produced by coal evaporating 12 pounds of water per pound of coal, and utiiising this steam in four cylinders at full pressure and with 60 tons available for driving-wheel adhesions, is a railway engine with a potential exceeding that of the largest engines built to the ample constructive gauges of central Europe. This by no means represents finality in power even for the English Great Western.

Continental locomotives approaching in power the new English engine are more interesting constructively, having regard to the fact

that the ruling condition of wheel-load there calls for greater ingenuity in the design, and the introduction of all available forms which allow the power to be increased without a corresponding increase in weight. In Austria with the maximum wheel load of 14.5 tons per pair, as many as eight large driving wheels would be required to utilise the power of the Great Western engine; in Italy the maximum permissible load is 14.7 tons; in Germany 16 tons; in France close on 18 tons; in Belgium 18 tons, and likely to be increased; while in England 20 and 21 tons give a free scope to the designer. Again, Continental coal evaporating only 6 pounds of water requires much larger fireboxes, consuming nearly twice as much coal in evaporating only the same quantity of water in the same time as the best English steam coal. In Austria the average evaporative power of the locomotive coal is only 5 pounds or, with lignite, 4 pounds. With larger fireboxes capable of evaporating as much water in the same time as English coal, the weight of the boiler must of necessity be much heavier. In sum, poor fuel and light rails and track are two opposing conditions requiring the greatest skill on the part of the locomotive designers in planning high-power, high-speed locomotives, and for this reason it appeared to me that examples of the most recent Continental practice would be the most instructive in this review.

Before entering into the details of construction or recent methods and practices of construction, it is desirable to refer to the locomotive types now prevailing in Europe. When writing here in 1902, the principal locomotive types mentioned were two-cylinder compounds or else four-cylinder compounds nearly all due to or imitated from forms originated by Mr. Alfred G. de Glehn, late Director of the Société Alsacienne de Construction Mécaniques of Mulhausen and Belfort; exceptions thereto were the tandem compounds—since abandoned as modern practice—and the "Adriatic" four-cylinder compounds. Since that period, however, a four-cylinder balanced compound engine that was not there mentioned as a distinct type has become, in the space of five years, the standard practice of almost every country in Europe except Prussia, France and England. It was represented at Paris in 1900 by three examples: that is, the four-cylinder balanced compound of the London & North-Western Railway, due to the ideas of the late Mr. F. W. Webb, the balanced compound of the Prussian State Railways due to the late Professor Von Borries, and the "Adriatic" balanced compound due to M. Plancher of the *ex* Meridionali Railways of Italy. In these three types all cylinders are bolted together in one block, all drive on one balanced axle and have one set of valve mechanism for four cylinders. The origin of the various

"systems" of multiple-cylinder locomotive engines now in extended use in Europe and America may be given here in order to facilitate future references to the subject of engine arrangements:

CENTRAL-EUROPEAN SYSTEM.

Cylinder castings bolted together.

Balanced drive.

1884. Four-cylinder balanced compound locomotive, "Vulcan," converted by Charles Sandiford, Scinde, Punjaub & Delhi Ry.

1892. First regular series of balanced compound locomotives. Nos. 4521-4530. Messrs. Henry & Vallancien. Paris-Lyon Ry.

1897. Four-cylinder balanced compound locomotives. "Black Prince" series. F. W. Webb. London & North Western Ry.

1897. Four-cylinder balanced compound locomotives. "3408" series. Professor von Borries, Prussian State Railways.

1905. Adoption by Belgian State Railways:
+ Compounds, Type 19, and non-compound, Nos. 3302-3303.—Fig. 53.

1906. Four-cylinder balanced compound. English North-Eastern.

1905. Four-cylinder balanced compound for coal trains. Lancashire & Yorkshire Ry.

MIXED SYSTEMS.

Cylinder castings bolted together.

Divided engines.

1889. (Beginning of) Regular series of four-cylinder divided compounds, the first having side rods. Messrs. Henry & Baudry. Paris-Lyon Ry.

Types:
C. 1 & C. 2—express.
3201-3202—freight.
4301-4302—mountain.
Modern derivative.—Fig. 55.

1902. Freight locomotives for French "Midi" Ry. De Glehn design.

1905. Type 19 bis.—Fig. 54.
+ Belgian State.

1906. Great Northern. Compound. Mr. Ivatt.

WEBB-DE GLEHN SYSTEMS.

Separated cylinders.

Divided engines.

1881. Three-cylinder divided compound locomotive, "Experiment." F. W. Webb. London & North-Western Ry., without side rods.

1886. (Beginning.) Four-cylinder divided compound locomotive, "No. 701," without side rods. A. G. de Glehn. French "Nord" Ry.

1891. Aug.-Sep. Divided compound locomotives, Nos. 2121-2122, built for side rods. Messrs. du Bousquet & de Glehn. French "Nord" Ry.

1900. Adopted for Saxon State Railways and since abandoned.

1901. Adopted for Bavarian State Railways and since abandoned. — Fig. 13.

1906. Great Northern "Vulcan" Co. Compound. No. 1300.
London & South West. Non-compounds.

1907. Great West. Ry.

1908. + Non-compounds. —Fig. 27.

Examples marked thus + have only one set of valve mechanisms and a rocker transmission for the second set of valves similar in arrangement to that introduced by Mr. Webb for his four-cylinder balanced engines.

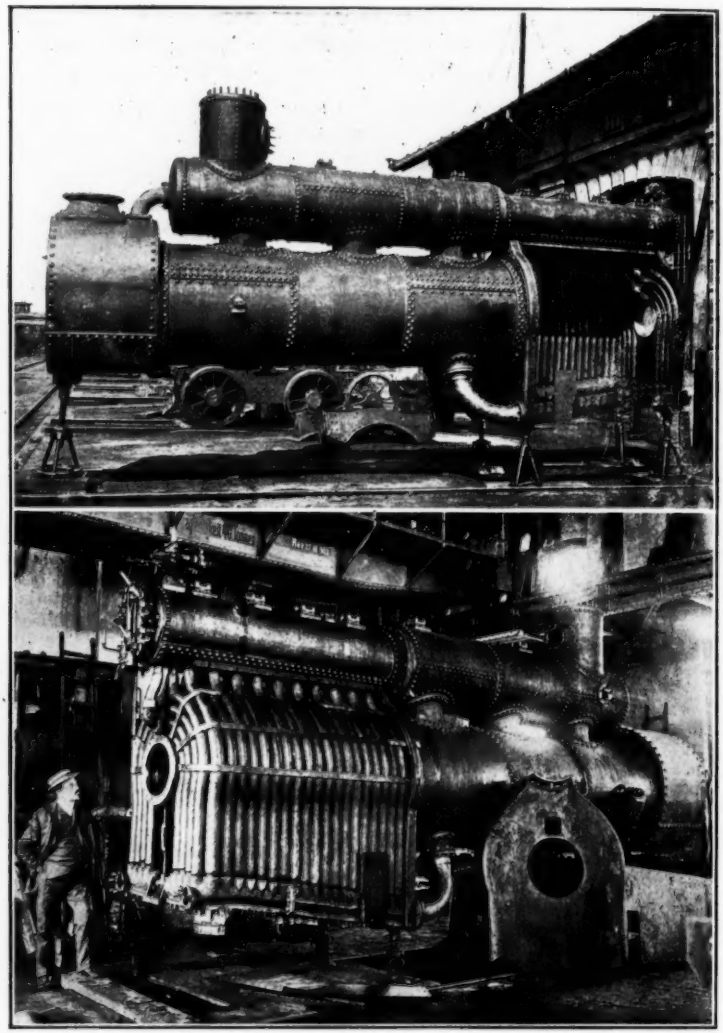

FIG. I. BROTAN WATER-TUBE FIREBOX.

Since 1902 the most notable change has been the general adoption of the simple four-cylinder arrangement now common in Central Europe and in America—as indicated in the first column. The mixed system indicated in the second column has been revived upon the

French Paris-Lyons Railways and adopted for certain types on the Belgian State Railways. The du Bousquet arrangement of the de Glehn compound is adhered to at present by the larger number of French railways, Swiss Railways, and a certain number of de Glehn locomotives continue work in Prussia and Belgium. As shown in the third column a compromise of the Webb and de Glehn arrangements for single-expansion four-cylinder locomotives is being adopted by at least two English railways.

The three different cylinder arrangements now being followed are therefore derived from models long existing—that is, the Sandiford, the Henry and the Webb. The chief improvements of the last few years have been, first the simplification in construction of the first and second models, the reduction in the number of valve mechanisms practicable in all four-cylinder types of any model, and the wide and growing use of piston valves. The application of poppet and Corliss type valves is, thus far, too rare to be considered as locomotive practice.

The changes introduced in the boilers are more notable than in the machinery. The water-tube boiler of Brotan, of which some illustrations accompany this article, has been much more successful than was generally anticipated. More locomotives in Austria are to have this form of boiler, which is also being tried in Switzerland. See Figure 1.

On the French "Nord" railway the water-tube firebox on the du Temple system is composed of small water tubes openly spaced out and running between the lower water-legs and upper collector drum, the rest of the boiler—the barrel—being of the ordinary type, thus differing from the Robert entirely water-tube boiler of the Paris-Lyons Company and also from the entire water-tube boiler of William R. Macklind. Locomotive engineers are aware of the greater efficiency of the water-tube boiler, but are loth to undertake the arduous task of experimenting, preferring to leave the anxiety and expense of evolving a practical locomotive-type water-tube generator to the more restless. A recent visit to the "Nord" works showed that if the water-tube firebox of that line is made a success for locomotives, the "Nord" Company will merit considerable praise for its venture. The locomotive is of the four-connected type,* *oo OO o,* but a four-wheeled truck, *oo OO oo,* has since been introduced to carry the weight beneath the trailing end. The boiler pressure is 228 pounds and in the running department the engine is said to start away with extraordinary speed.

* The method of wheel notation employed in this article is brief, concise and instantly

Another change in boilers is the introduction of steam pipes for reheating the steam. The reintroduction of superheaters for locomotives now appears as an added element of fuel economy, which would perhaps prove more practical were it combined with water-tube rather than fire-tube boilers. So far, the superheaters consisting of steam pipes lodged in the smoke flues and conveying the steam twice backwards and twice forwards throughout the length of the boiler barrel, have proved to be the more successful. This superheater system in a practical form, but contrived without complicated arrangements such have been introduced into recent modifications, was invented and patented in 1850 by Jean de Montcheuil, the chief mechanical engineer of a French railway. It appears quite possible that this original multitubular superheater will eventually prove to be the most efficient of its type. Whatever measure of economy its use may realise the results will be free from the conflicting figures of rival commercial enterprises. It is perhaps but a small honor to the forgotten inventor to record his remarkable and important invention here. See Figure 2.

In the details of construction the practice of Europe follows later, but surely, the results of experience obtained in the United States—which are the pioneers in the production of forms suited to large units. In the adoption of the pilot truck, outside cylinders, large boilers, flanged smokebox tube plates, wide fireboxes, sloped front water legs, sloped boiler heads, vertical gussets and diagonal rods for staying the latter, American wheel arrangements and the reintroduction of bar frames, Europe has learnt the fitness of American arrangements. But not until faced with urgent necessity have the transatlantic forms been adopted, for—and it would be foolish to conceal the fact—European experience of American materials, American workmanship and American design of cylinders, and all that belongs to the motion, has been such as to prejudice the mind greatly against American types. The most progressive designers and makers have reasoned that the American system was good, but that the construc-

legible to all readers in all countries. The other systems require a mental effort to translate where yet other systems are in vogue.

The graphic method is largely employed in drawing offices where visual effect saves useless mental effort.

	English method.	Continental.		Universal.	
Brevity.	0—6—0	C—3—0	(5 signs)	OOO	(3 signs)
	4—4—0	2—2—0	(5 signs)	oo OO	(4 signs)
	4—6—0	2—3—0	(5 signs)	oo OOO	(5 signs)
Precision.	2—8—0 Duplex engine =			o OO + OO	
	2—10—0 Mallet engine =			o OO + OOO	
	2—4—0 Webb engine =			o O + O	

For accuracy, brevity and intelligibility in all countries the graphic method is preferable for all whose time is precious.

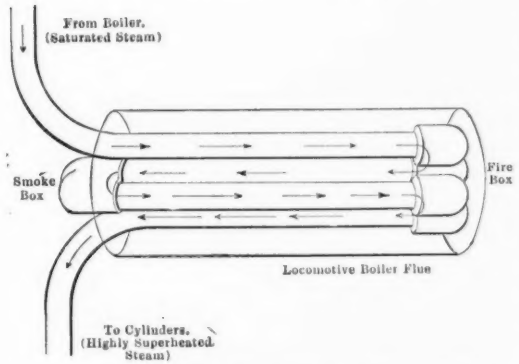

FIG. 2. THE EARLIEST PRACTICAL TUBE SUPERHEATER.
Montcheuil patented system, 1850, fire-flue multitubular superheater for locomotives.

tion materials or details in the form were susceptible of improvement.

The first firm in Europe to adopt the American models largely, in an improved form, is J. A. Maffei, whose works, situated in the sylvan recesses of the "English Garden" on the banks of the milky Isar, at Muenchen in Bavaria, are a familiar objective point for the American engineer when in Europe. This firm has combined the American boiler, frame, and wheel arrangements with the most approved type of Continental balanced compound engine, under a general form of superior elegance, as will be observed from the accompanying examples of different types designed by the firm. For the purpose of comparison the first three European locomotives of the "Pacific" type—French, Bavarian and English builds—are illustrated in these pages. The English type is perhaps the most pleasing, principally because the mere accessories as sand-box pipes, oil pump, speed-indicator bracket, rods to live-steam inlet valves, are invisible or absent as compared with the Bavarian-built engine. The valve motion is inside in the first and entirely outside in the second. In the latter the whole of the inside and outside motions are most readily accessible at all times and places—and this is an important practical advantage not to be ignored for the sake of avoiding a display of the mechanism—which is not one whit more simple, rod for rod and pin for pin, in the one machine than in the other. The French engine differs from the preceding types in that it has two complete sets of reversing gears and four valve mechanisms. It has, in common with the English machine, special frame bracings for the support of the outside cylinders—which are dispensed with, with notable advantage, in the Bavarian-built machine. But the new French engine has no outside main steam pipe as usual in most French locomotives. Each engine is interesting for new features which will be described in due course.

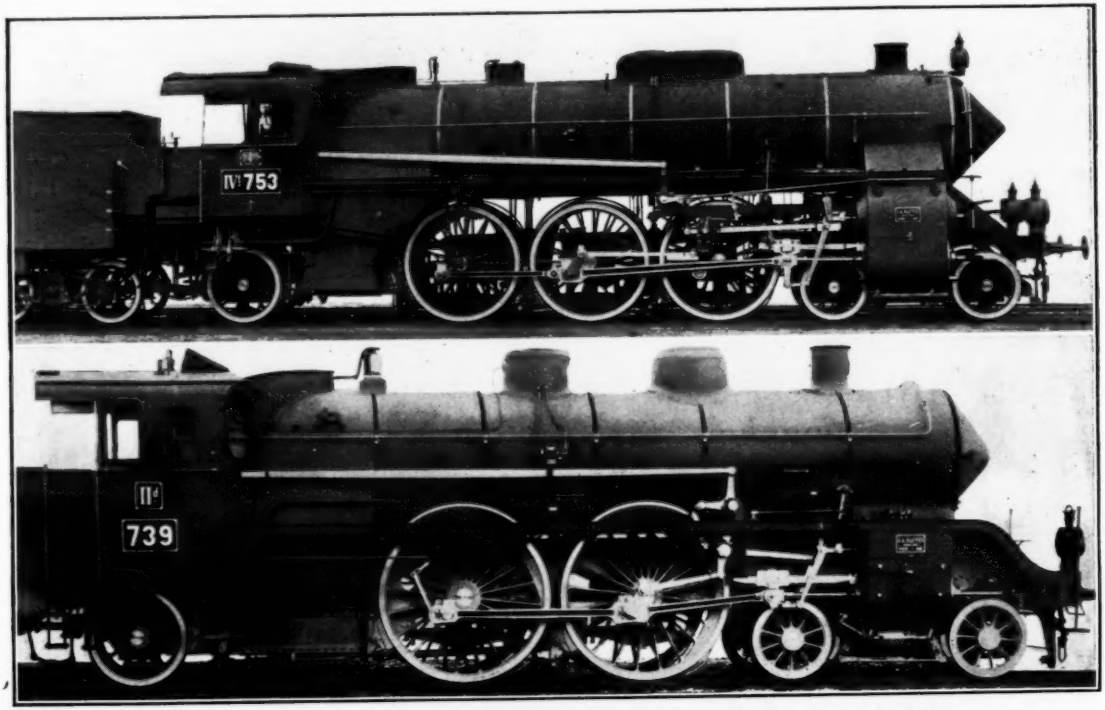

FIG. 4. BALANCED COMPOUND, UTILISING SUPERHEATED STEAM, BADEN STATE RAILWAYS.

FIG. 3. BALANCED COMPOUND, PROTOTYPE OF BAVARIAN HIGH-SPEED LOCOMOTIVES. RAN 90 MILES AN HOUR ON RISING GRADIENT.

LOCOMOTIVES BUILT BY J. A. MAFFEI OF MUNICH.

Baden State Railway. The *oo OO o* type locomotive shown in Figure 3 was Maffei's first design of the Central European balanced compound engine, which, in the year 1904, ran at higher speeds than were ever before attained under equal conditions, by a European steam locomotive—that is, an average start-to-stop speed of 72 miles per hour for a distance of 39¼ miles on a continuous rising gradient, the difference between levels at either end being 359 feet, the car load 138 metric tons and the maximum speed, on a short level, 90 miles per hour. The full-way speeds for the whole journey varied between 75 and 84 miles per hour on the ascending grade. This locomotive was designed for trains running up to 56 miles per hour, average, or up to 62 miles per hour in making up time. It was built before experience had given full confidence in the use of piston valves and at a time when it was deemed advisable to provide at least the low-pressure cylinders with flat valves. The locomotive has also flat rolled frames; in all other respects it is typical of the most recent practice.

FIG. 5. BOILER FOR PACIFIC-TYPE LOCOMOTIVE, BADEN STATE RAILWAYS.

The *oo OOO o*, or "Pacific"-type locomotive, Figure 4, for the same Baden State Railways, combines all the most recent improvements of the firm Maffei. It has piston valves to all cylinders, bar frames, latest-pattern boiler fitted with superheating pipes according to the Schmidt arrangement. The boiler is of the wide firebox type with round crown to the firebox wrapper, according to the most generally approved practice of Europe, and as shown in the view Figure 5. The plates are rolled from best quality mild steel—*flusseisen*—by the Martin open-hearth basic process. The plates employed in Bavarian practice have, for flanged work, a tensile strength of 32 to 38 kilogrammes per square millimetre with a minimum elongation of 25 per cent, the sum of the two values being 62 minimum. The rest of the shell plates have a tensile strength of 36 to 42 kilogrammes per square millimetre with a minimum elongation of 22 per cent, the sum of the two being, in minmum, 61. Tests include bending the plates through an angle

of 180 degrees, hot and cold, and bending, after hardening, around a mandrel to a diameter equal to twice the thickness of the plate. Test strips 10 centimetres wide, and red-hot, must enlarge 1½ times their breadth under the hammer without showing crack or other flaw. The rivets of mild steel have a tensile strength of 34 kilogrammes per square millimetre with 20 per cent elongation, the minimum sum of the two values to be 54. The bending tests are the same as for the boiler plates.

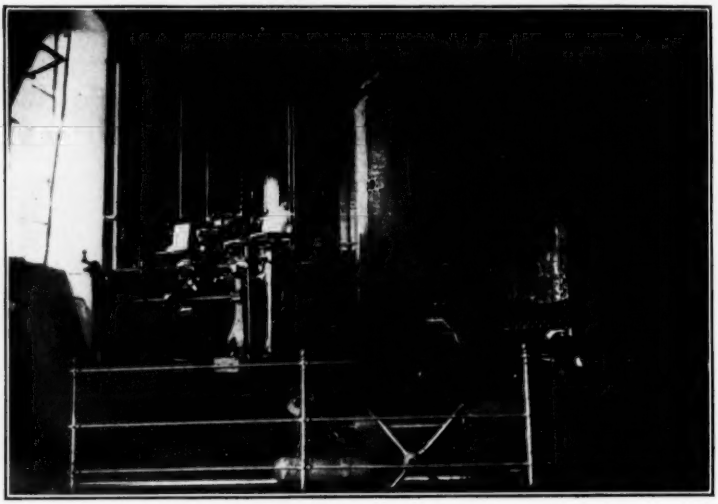

FIG. 6. MAFFEI-BUILT SPECIAL BOILER-DRILLING PLANT.

The plate-working shop at Maffei's is a fine building replete with bending rolls, planers and drills; but it is in a small annex to the old boiler-makers' shop that we find an interesting machine tool specially designed by Maffei for drilling the stay holes of very large modern fireboxes. A snap-shot view of this in Figure 6 shows that the firebox is clamped down by the throat sheet to a revolvable platform. The drilling machine is permanently fixed to the side of the boiler pit. The multiple drilling heads, with the operator's platform, move up or down the vertical slides, the controlling gear enabling rapid setting of the cutting tools to the punch marks on any part around the whole contour and height of the box. The inner box is of copper of the purest quality—99.5 per cent minimum—and of 21 kilogrammes per square millimetre tensile strength; 42 to 45 kilogrammes sectional contraction in minimum, and 38 per cent minimum elongation. The metal must bend at an angle of 180 degrees; and on a mandrel bend to

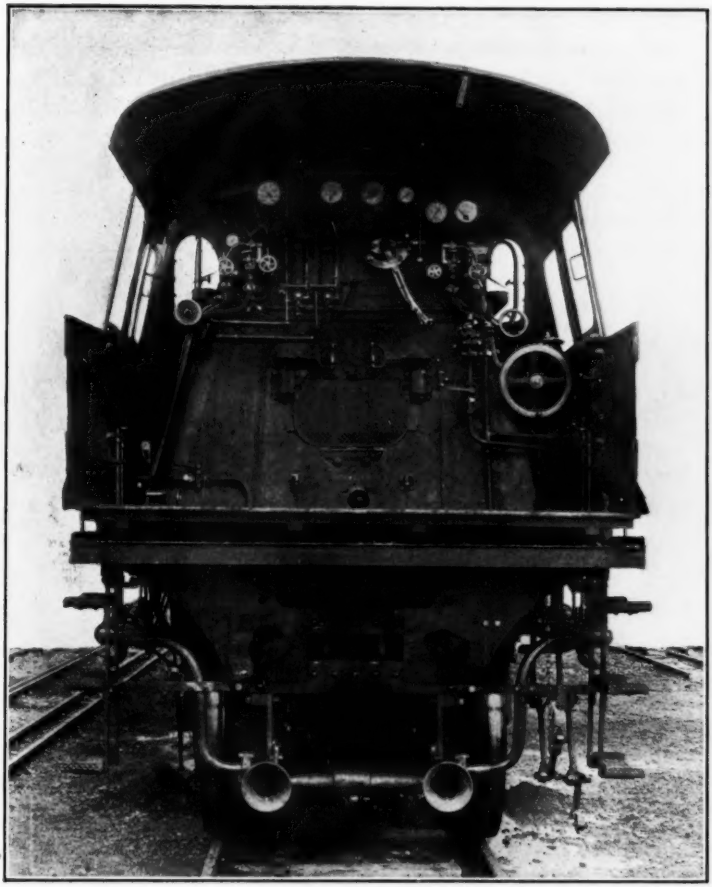

FIG. 7. BOILER HEAD, PACIFIC-TYPE BADEN LOCOMOTIVE.

a diameter equal to the thickness of the plate without sign of flaw. Copper tubes and ferrules are of the same quality. Copper stays have a tensile strength of 22 kilogrammes with minima of 45 per cent sectional contraction and 38 per cent elongation. The copper-stay rivet heads are left solid—that is the central hole is not opened out on the outside of the box. The inner and outer boxes are usually assembled at the fire-hole by means of forged iron space rings; and to this the new safety inside-opening firedoor is fitted—see back view, Figure 7. The cylinders for the Baden locomotive are shown in the view Figure 8. Here the inside group of two cylinders, two valve chests, the

saddle, and the legs forming a box brace, is in one piece; the two outside cylinders, with their valve chests, being each cast separately. This makes three pieces instead of only two as in the American plan. For facility in erection and for ease in removing the outside cylinders for reboring, etc., this three-piece arrangement is preferred. The receivers between high- and low-pressure cylinders are simple U castings as shown in Figure 8, and the steam is not carried around in a pipe to absorb the heat of the smokebox as is often practiced with receiv-

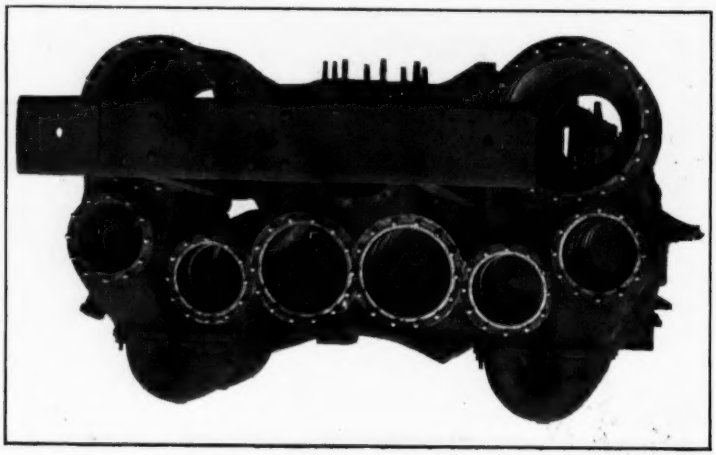

FIG. 8. CYLINDER CASTINGS ATTACHED TO FRAMES OF PACIFIC-TYPE BADEN LOCOMOTIVE.

ers. The whole group of cylinders has the appearance of being somewhat complicated, but in reality the disposition is of the simplest; and while there are no more parts here than in the four-cylinder engines now built for single-expansion, the arrangement is practically more simple than in any class of engine having the same number of cylinders, where those cylinders are bolted to different parts of the frames and so require, in addition, a heavy box bracing or caisson between the two outside cylinders; while the losses by heat radiation are greater in divided cylinders than where the whole mass of the cylinders is concentrated together; further important advantages are realised where the efforts of all four pistons are opposed, one against the other, in the same transverse plane. A side view of the cylinders is given in Figure 9. The four receivers connect the ends of the four valve-chests, the middle passage being for the admission of the steam. The outside valves are double-headed and triple-ported; the inside valves are single-headed. All valves give central, or inside, admission.

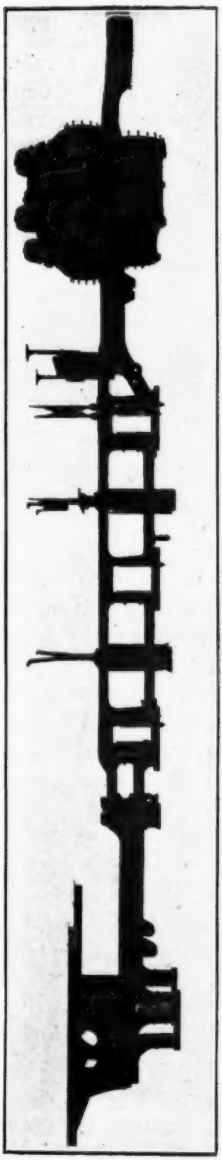

FIG. 9. BAR FRAMES, COMPLETE WITH ALL ATTACHMENTS, PACIFIC-TYPE BADEN LOCOMOTIVES.

There are only two valve mechanisms, precisely as in any two-cylinder engine, and the rocking shafts for actuating the inside high-pressure cylinders have simple equal-length arms. Comparatively, two-cylinder engines are really more complex than this simple type of four-cylinder engines, in that they require one valve gear for each cylinder, whereas the simplest of four-cylinder engines have only one mechanism for two cylinders.

The bar frames are also illustrated in the view Figure 9. An important advantage arising from the use of four cylinders is not only the preservation of the track but also the reduction, by half, of the maximum working stresses on the frames and all parts in connection. The bar frames as made by Maffei for balanced engines appear to have given most satisfactory results in practice, and their use is extending rapidly. This result is to be attributed to the high quality of the work in their production. They are forged from slabs of best-best iron of selected scrap, double-fagoted, welded, and hammered, the welds being well removed from the neighborhood of motor efforts. After the frames are forged they are annealed and then placed on the machine depicted in the view Figure 9 A, which was made specially for this class of locomotive work by the celebrated firm Collet & Englehardt. The frames shown on the machine are for the *oo OOO o* type Baden balanced compounds. The notable feature of this machining is that the material is milled away to a depth often of 3/8 inch, which entirely removes the outside hide even in the thinnest parts of the forging, and thus the structure of the metal is liberated from unequal tensions tending to buckle a plate

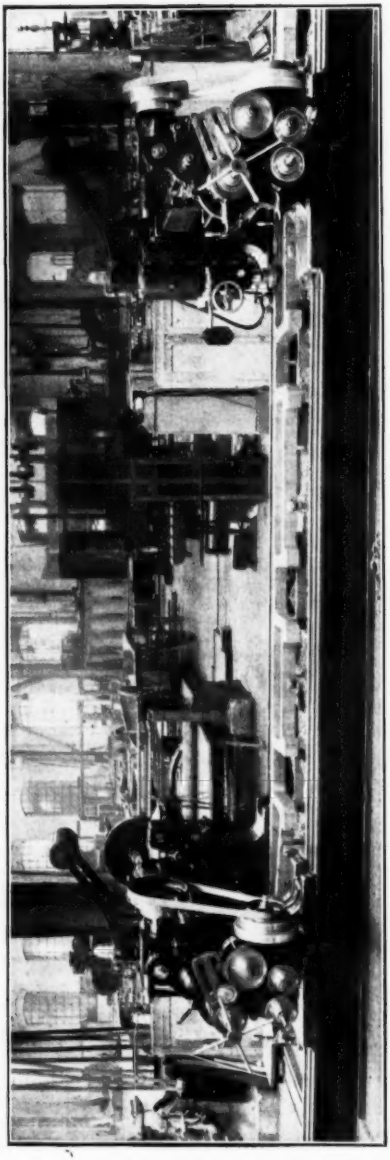

FIG. 9A. SPECIAL MILLING MACHINE AT WORK ON PACIFIC-TYPE ENGINE FRAMES.

having different grades of homogeneity. The machine leaves the frames with a fine surface finish on both sides. The traversing motion of the milling tools—for milling the pedestals or axle-box guides—is better understood from the snap-shot picture, Figure 10, made of the machine whilst working. The frames are then removed to the adjoining slotting machines, which are of the universally employed type of the Saxon Engine Works of Chemnitz—see Figure 11. Generally not more than two frames are slotted together at the one time. The frames are thus finely machined over every inch of their surface and the work of tracing proceeds upon perfectly true bases, the subsequent erection and fitting up of front and back extensions and of the various parts for the running gear being greatly simplified and facilitated.

The advantages experienced in Europe with bar frames are: saving of weight, less number of bolts and rivets, interchangeability of pieces by which reserve parts may be kept in store and replace broken parts at all

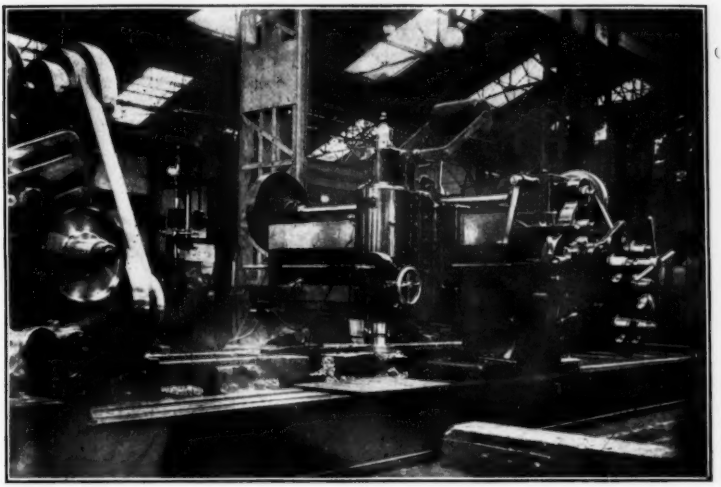

FIG. 10. MILLING BAR FRAMES FOR NEW BAR-FRAME LOCOMOTIVES.

times certain of a good fit, and finally greater ease in erecting all parts that have to be attached to the frames, and much greater convenience to the enginemen who can inspect all inside parts of the motion without half the effort entailed with plate frames.

The running gear, axles, wheel centres and tires are, as usual in most European locomotive works, procured from large steel works. It is, indeed, rare to find engine builders rolling their own tires, etc., as practiced by the English Lancashire & Yorkshire Railway Co. The

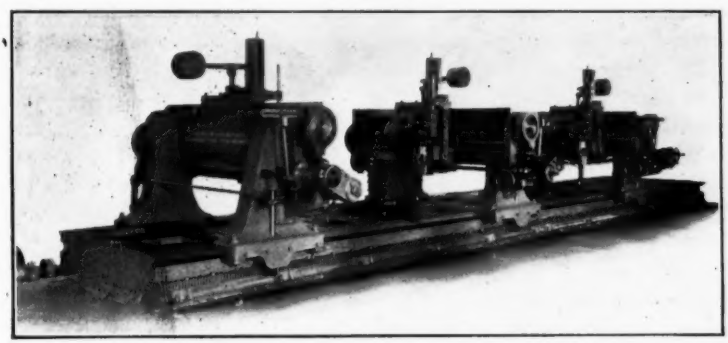

FIG. 11. TRIPLE SLOTTING MACHINE FOR LOCOMOTIVE FRAME PLATES.

Mattei works, Munich. For automatically machining straight edges or circular holes, in longitudinal or transverse direction. 300-millimetres stroke.

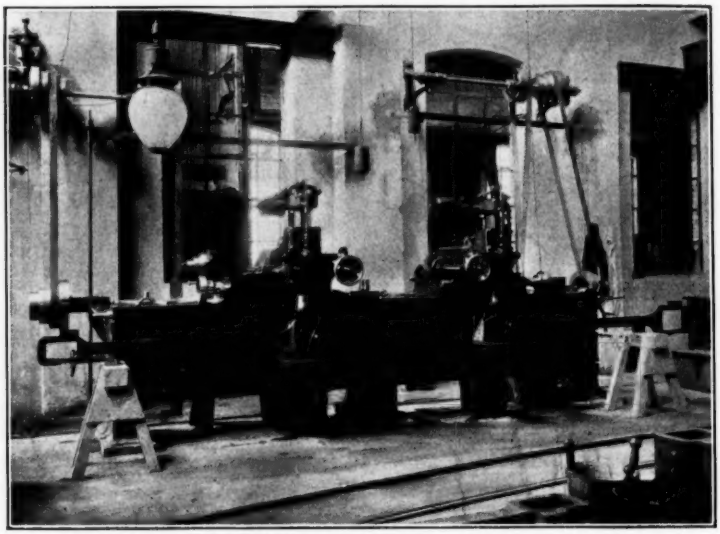

FIG. 12. DOUBLE-SPINDLE LOCOMOTIVE MAIN-ROD OIL-CUP MILLING MACHINE.

engine motion, rods, etc., are forged at the works. In design they are always characterised by most carefully studied proportions, and of marked elegance. Weight having to be cut down in every part, lightness is of great consideration—hence the reduction in the bulk of the pieces, and in their number wherever one piece can be made to do the work of two. The single guide-bar of the crossheads in Figure 4 may, for example, be compared with the guide bars of the smaller cylinders in Figure 27. In the latter case weight is of small import and durability can be increased by greater strength in proportions. The Maffei engine work is also fine in its finish. The rods are always channeled—Kendall & Gent milling tools being employed for this work. The oil boxes are fashioned in the forgings by means of a special double-headed milling tool by Zimmerman which is shown in Figure 12, at work on a pair of rods. The milling cutter has an eccentric movement and automatically finishes a deep oblong cavity to the required dimensions.

The axles of the driving wheels are cranked in Z form according to the now almost general practice of the Continent. The straight parts of the axle—journals and cranks—are hollow. This form of cranked axle (Figure 12 A)—derived from the old Martin type—is said to be very satisfactory. In countries where it is only adopted at present to a relatively small extent, it is conceded to be so good as

never to have failed during a number of years since its adoption; yet it is said to be unable to command entire adoption because its form does not allow of such complete consolidation under the hammer as the ordinary right-angle form, and also because of its higher price.

The cranked axles are usually of nickel steel. The other axles are of cast steel and crucible cast steel. The nickel steel has a tensile strength of 55-65 kilogrammes, cast steel 50-55 kilogrammes, crucible cast steel 55-60 kilogrammes, the sectional contraction of cast-steel and nickel steel being in minimum 40 per cent, the sum of the two values not to be less than 95. The tires are of crucible cast steel having a tensile strength of 65 to 73 kilogrammes per square millimetre, 30 per cent minimum sectional contraction, the sum of the two values being 95. For turning tires, etc., several Niles' lathes are in use.

The foregoing description applies generally also to the locomotives of the Bavarian State Railways. This latter administration adopted the Central European engine type only two years later than the very progressive Baden State Railways:—1902:1904. Both commenced with the French four-cylinder types. The Bavarian 1901 model of the de Glehn engine is illustrated in Figure 13. It has four valve gears as usual. These are excellent engines for light express trains but the complicated arrangement of the outside cylinders, fixed at a

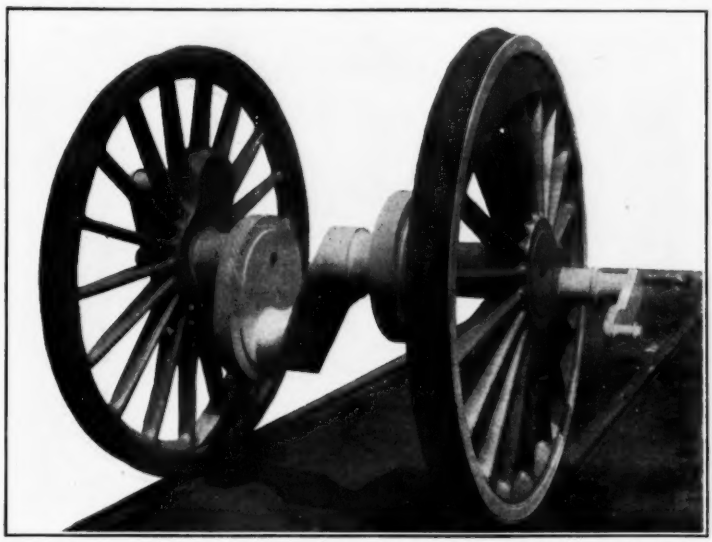

FIG. 12A. Z-TYPE NICKEL-STEEL CRANK AXLE, BORED OUT HOLLOW.

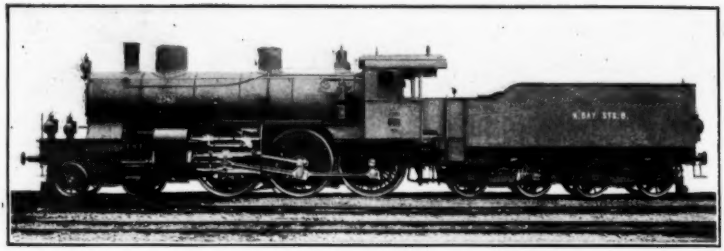

FIG. 13. FIRST DE GLEHN LOCOMOTIVE FOR BAVARIAN STATE RAILWAYS.
High-speed four-cylinder compound.

different position to the inside cylinders, their liability to slacken the bolts after hard working, the trouble with the pipes that run along between the two pairs of cylinders, the complication of two valve sets, and the difficulty of inspecting the inside motion whilst on the road where no track pits are available, have resulted in this type being replaced by the simple arrangement seen in the *oo OOO* and *oo OO o* Bavarian locomotives illustrated in Figure 14 and Figure 15. With a wheel load of 16 tons per pair the class of service required of each of these types will be fairly understood. The "Atlantic" type is able to run at speeds much in excess of the maximum velocities allowable in ordinary service. Pulling the Brenner Pass express between Ber-

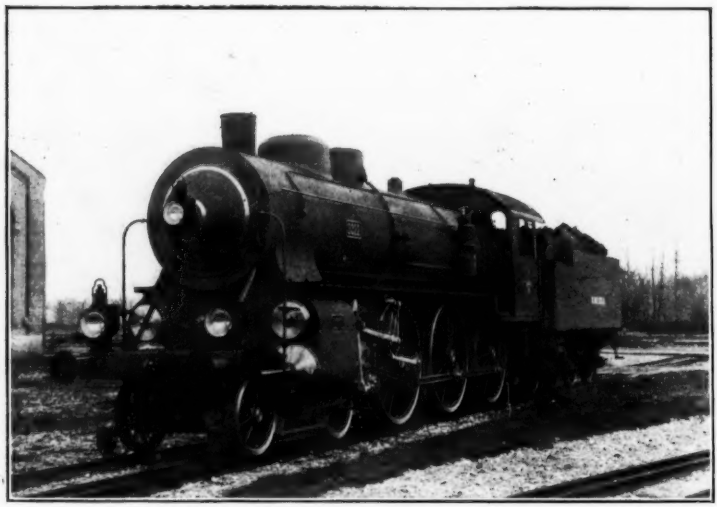

FIG. 14. BALANCED COMPOUND WITH SUPERHEAT FOR HEAVY TRAINS ON HILLY LINES, BAVARIAN STATE RAILWAYS.

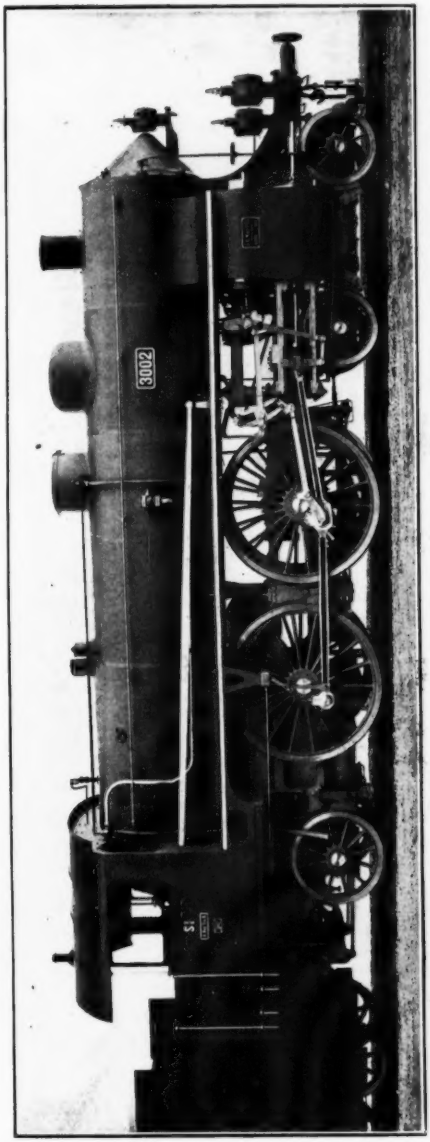

FIG. 15. FOUR-CYLINDER COMPOUND, BAVARIAN STATE RAILWAYS. BAR FRAMES MILLED AND SLOTTED ON ALL SIDES.

lin and Venice, via the Austrian Tyrol, with a load of 255 metric tons behind the tender, the speed of 60 miles per hour can be maintained for miles together on continuous grades rising 1 in 300, 1 in 350; and 70 miles per hour is the pace in descending the same gradients. This occurs with the special express on the stretch between Muenchen and Rosenheim near the Austrian frontier. The *oo OO oo* locomotive, Figure 16, was built for speeds of 94 miles per hour on the Bavarian State Railways, and between Muenchen and Augsburg it has run a considerable distance with a train of 150 tons at 96 miles per hour, the average start-to-stop speed for the 37½ miles being 81 miles per hour—the record for the steam locomotive in Europe. The locomotive is similar in construction to all the balanced compounds designed by Maffei except that a grate area of 50 square feet is provided for the rate of evaporation required by

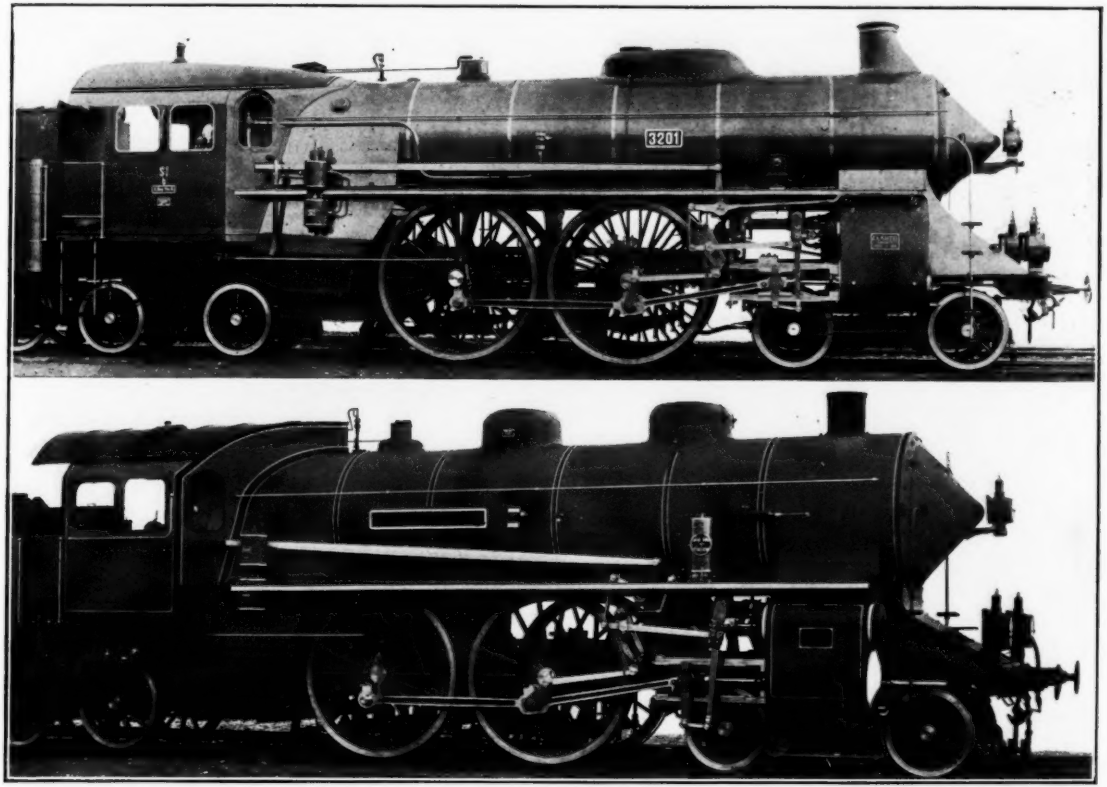

FIG. 16. HIGH-SUPERHEAT BALANCED COMPOUND, BAVARIAN STATE RAILWAYS. AVERAGE START-TO-STOP SPEED OVER 80 MILES AN HOUR.

FIG. 17. FOUR-CYLINDER BALANCED COMPOUND, PFAELZ RAILWAYS. PIELOCK SUPERHEATER, AUTOMATIC FIRE-BLOWING AND SMOKE PREVENTION DEVICE.

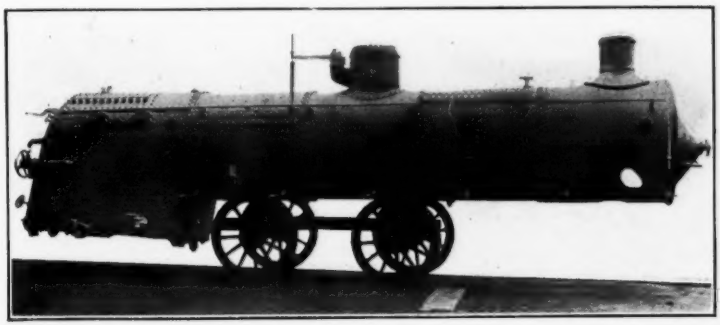

FIG. 18. WIDE-TYPE FIREBOX AND PARALLEL BOILER, APPROVED IN RECENT CONTINENTAL PRACTICE.

mediocre coal, averaging about 1:6 only, and to supply the volume required at 205-pounds pressure and at 300 degrees C. temperature. This large firebox accounts for the special wheel arrangement; and the great diameter of the driving wheels—7 feet 2 inches—is responsible for the height of the boiler—9 feet 10 inches to center.

The Pfaelz Railways of the Bavarian Palatinate, connecting the Baden Railways with the Prussian railways of the Rhineland and of the Reichland—Alsace-Lorraine—have their own type of balanced compound as illustrated in Figure 17. It is always of the Maffei engine type and with bar frames; but in this case the Schmidt superheater arrangement is replaced with the Pielock apparatus located in the boiler barrel, and the locomotive has a special fire-blowing apparatus of the Staby-Koerting system—steam-operated air jets blowing at will on the surface of the fire—by which the dense black smoke of Saarbrucken coal is suppressed, the fuel economised, and the rate of combustion increased when required—a device which should be of value in Italian railway tunnels where, even with viscid naphtha fed on a coal fire with Holden burners, the air, where the ventilation is deficient, is not at present supplied in volume sufficient for the very large locomotives in service.

THE YOUNG AMERICAN WORKMAN AS SEEN BY A SHOP SUPERINTENDENT.

By C. R. McGahey.

Mr. McGahey's experience in his subject is as large, direct, and practical as that of our New England correspondent in the April issue to whom he replies. He also is a graduate from the moulding floor and the bench. His interpretation of modern American conditions is interestingly different. From his point of view the inferior quality and the poor spirit of the American apprentice are not due to the indifference of employers, but to lax home training and to the false standards suggested by the unions. He finds a hopeful and elevating influence in the trade school, and makes some interesting recommendations to superintendents and employers for the treatment of the boy or the young workman in the shop.—THE EDITORS.

A VERY interesting article on American industrial conditions from a workman's viewpoint, which appeared in THE ENGINEERING MAGAZINE for April, prompts me to reply, or at least to express an opinion upon conditions as they appear from another point of view.

My experience has been perhaps that of a smaller number of men, because opportunities in the South twenty-five years back were not what they were in the New England States. The young man who sought to become a thorough mechanic there found his school at his door. The conditions here were much different. But I will venture to say that the materials for making the man were the same. Allowing to the New England States all the advantage of the shops and schools for the boy who wished to learn, I yet contend from actual experience and observation that the boy of today is not the same. The deterioration is due, in my opinion, entirely to the new training he receives from his parents. The boy of today is often—even usually—the "boss" when he is about ten years of age. Such conditions at home will follow largely into the shop or the industrial establishment; this, combined with the get-there-quick idea running in his head, and the union atmosphere of many of our shops, is actually ruining the country.

The boy's desire today (though many times it proves his sorrow) —his one object—is to get a "card." "I have my card"—this foolish and unsound expression is heard everywhere. The young man's wish to advance may be genuine, but his real welfare has not been shown

to him. The author of the article referred to above was a man of many years' experience. I, also, have worked through several branches, and for some years have been general superintendent of large plants with active experience. I have had many young men come to me for a position, having served their time, and they will promptly tell me that they have their card. To my mind this is of no value and, indeed, serves to put false ideas into the young workman's head. These young "card men," tried on simple jobs, could not chuck a plain, ordinary piece of work—proof enough that the card does not make a mechanic.

I have often said that I do not care how many cards a man has if he is a mechanic and can do the work; but there is one teaching among the Southern branch of the "card gang" which is very apparent. You may take a young workman and show him the proper speed at which to run his tool; when you come by again soon you may find that the speed has been set back; some card man has told him it was too fast for a union man. Here is where I have always clashed with the union. They have their rights outside the shop, but not within it.

I wish to express belief that there is a fair solution to the problem of the technical-school course. The boys from these schools are somewhat different from others. A young man who has ambition and persistence enough to go through one of these schools is worth more than the ordinary "scrub" and is more capable; but in justice we must recognize that our shops have many youngsters made of just as good timber. The whole thing lies just here: How can we pay a uniform scale of wages until all men are born equal and alike? We must be satisfied at this stage of the world to accept differences; we can not all be President of the United States or superintendent of the works; but more of us than now seem to admit it could do better than we are doing, and could improve our position in the world by studying and attending to our own business. Knowledge is power—a greater power than the card; the young man who will devote his spare moments as the New England writer did, to work out of time in the shop, practicing a hard job, will come out all right. The boy who wants to do right will get proper instructions; he can get them if he really desires.

Returning to the trade-school boys; I want to point out an important point. They will try to run their tools and produce the work as directed by the foreman. You will notice that they have learned the lesson to obey at school, while the other boys have not

learned this either in school or at home. This defect of home training is being felt throughout the whole country, in all departments of work, and what we shall do in the future for good all-around mechanics is a mystery to me. Many of our shops are willing to teach boys, but what do they get in return? When the apprentice has been in the shop about two years, he becomes dissatisfied with his pay and leaves to enter another shop as a journeyman. I believe that manufacturing concerns should require a written certificate as to the past whereabouts of men applying for positions; it would tend to correct this evil.

The unions in practice tend to lower the standard of the mechanics of the country; they condemn the handy man; in times of strikes they will take in laborers or anybody to try to win their point. They may be good in principle, but not as managed in present practice. Our shop managers should wake up to the true valuation of young men of merit, and pay according to their ability and their worth to the concern. This would tend to check their movement away—to secure selected material—to make real mechanics; then we should teach them system, etc.

All men are not alike, nor can all accomplish the same in life. Where a vast difference exists in young men it should be recognized and the abler should be compensated for their efforts in behalf of the employer. Often a young man is turned down by the manager of the concern with which he is employed and this cuts his ambition and turns him against his own shop. Superintendents and managers, therefore, should be careful in their attitude toward their young men, listening to their wants, and granting those that are right. Fairness and justness in early training will make good workmen—men who can not be led off easily by the trouble-maker.

Experience has taught me that it is best to keep in touch with the young mechanic. If you do, you will have a man who can be much more depended upon.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

III. ECONOMY IN THE USE OF MATERIALS AND TIME.

Mr. Knoeppel's initial article, in our April issue, reviewed the conditions under which the internal factory organization will work at its highest efficiency. The second of the series showed the results obtainable by proper system in processing, machining, assembly, and erection. A fourth and concluding article in July will deal with the means for assuring better deliveries—more satisfied customers.—THE EDITORS.

IF it were possible by a simple turn of the hand to transform the energy which is wasted in a number of manufacturing establishments into the same amount of efficiency, the results would be such as would lead a manufacturer to turn his hand without any delay. The great trouble is that many business men get so accustomed to seeing energy lost that they do not give the matter much intelligent consideration until quite a little live steam has escaped. They either forget or neglect to lock the door *before* the horse is stolen.

How much time are you paying for which is producing you nothing? Time is an important element in production, and it naturally follows that any lost or wasted time means a certain decrease in the amount of an output. The following illustration will serve to show what lost time may mean to a manufacturer. If we assume that 200 producers lose only 2 minutes each hour, we have 66.6 lost hours at the end of a 10-hour day, which in 300 days to the year would amount to *19,980* hours. Figuring each hour on the basis of 20 cents would mean that lost time, in labor alone, would amount to *$3,996*, not counting the fact that considerable money is lost in the way of an output, which would not be the case could these 19,980 hours have been utilized to advantage. Consider the number of machines which could be built in this lost time alone!

Doubtless every reader of this article can call to mind a plant where the production could be materially increased if wasted time could be used to advantage—where men have to wait around after finishing one job before receiving another—where the stock clerk is obliged to spend considerable time in looking over his stock before knowing whether a certain part is in stock or not—where machines

are often idle until work can be found for them—where the assemblers are kept waiting for parts being machined before they are able to complete a unit—where it is often necessary for the shipping clerk to be on the jump a good share of the time to find a part here and a piece there before shipment of a machine can be made—where it is necessary for someone to be constantly interviewing various persons in an endeavor to find the status of an order—where more than a reasonable amount of time is consumed by men in taking work out of their machines, in order to finish a *rush* or *forgotten* order, then putting back the work they had taken out on the start—where machines are about ready to ship only to find that some part has been neglected or forgotten—where it is necessary to spend considerable time running to the office and drawing room for certain information before a part can be machined or a unit assembled. Add to these the harmful effects of friction between those in authority, the turmoil, confusion, etc., and we have a condition of affairs for which there is no excuse and which is responsible, to a large degree, for lack of maximum results. Efficiency in production can be brought about only after we have either eliminated these conditions altogether or reduced the wasted time to a minimum. I will admit that it is impossible to have everything go right all of the time, but everything can be so handled as to make things go right most of the time.

The first article in this series dwelt at some length on the necessity for a carefully worked out organization that the various forces might be harmoniously united; the second briefly analyzed the industrial body, providing a means for taking care of the information necessary to facilitate production; this article will go a step further and outline such methods as have for their ultimate purpose the handling of the greatest amount of work in the shortest space of time consistent with good workmanship. In order to do so, we will assume that a business has been organized to manufacture certain machines, all raw materials to be purchased outside, labor being paid by the day, the shop manufacturing departments being:—

Assembly Department.
Lathe and Planer Department.
Milling Department.
Drilling Department.
Forging Department.
} Machining Department.

The connecting link between the factory or engineering branch of the business and those who consume its output is the office or commercial branch; much therefore depends upon how it is managed, and too much importance cannot be attached to the necessity of having

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

OFFICE COPY

Buffalo, N. Y., June 23 1907.

Sold To	William Jenkins and Company	Date Sold	June 21 1907
Address	Utica, New York	Sold By	Johnson
Destination	" "	Our Order #	3445
Ship Via	Fast freight	Their Order #	A 25589

One cylinder head	X 442	3441
One cylinder	B 20	2811
One piston	X 440	3441

This is a rush order.

The Eng. Magazine

FORM I. INITIAL RECORD OF ORDER. MADE IN QUADRUPLICATE.

some definite understanding, on the start, as regards the way details shall be handled; otherwise costly blunders are bound to occur. To illustrate. If orders are given by more than one person, or if they can be given by more than one department, it is only natural to expect that some orders will be entered twice, or some not at all, each person or department thinking that the matter has been looked after by the other. Delegate certain lines of work to those most competent, make the supervision such as will take care of the detail properly, and it will be found that there will be less confusion and mistakes.

All orders and letters pertaining to orders should therefore be sent to the order department before anything else is done with them. This is our starting point; and that the office may have a record of each order, that the works manager may know what the shop is expected to build, that the shipping and stock departments may also have this information, and that the customer may be advised that the order has been received and entered, four copies of the order should be made, Form I being the office record, the one sent to the customer bearing the regulation acknowledgement advice and the possible date of shipment.

The drawing room, having been made responsible for the accuracy of all orders entered, should state what is necessary to furnish, giving the commercial as well as the shop classifications. In order to do this, they naturally need the original order to know what the customer

PURCHASE REQUISITOIN

PURCHASE ORD. NO. 3160	DEPARTMENT Machine	REQUISITION NO. 984	DATE 6-10-7

NO.	DESCRIPTION
10	Castings X 560
5	" X 430
25	" B 64
100	" G 540
	Rush X 560

PURPOSE:- Name	Stock	S.O.Number	
Order of	Star Fdry Co	Address	Newyork
Ship to	us		
Address			
How to Ship	Frt	When Wanted	At once
Signed by	LBC	Approved by	J.K.S.

The Eng Magazine

FORM 2. REQUISITION FOR MATERIAL.

really ordered; but the order department, in turn, must have some means of knowing where the order is before it is entered and finally filed away. The order department therefore takes the four copies above mentioned, fills in the headings only, and sends the office copy, with the original order from the customer, to the drawing room, leaving the three remaining copies of the order on the desk of the chief order clerk, which will show, at all times, the orders received but not as yet entered. The drawing room takes the order, looks up the necessary information, makes a "list of material," (Form 1, pp. 232-233, THE ENGINEERING MAGAZINE, May, 1908), if the order calls for a number of parts or if for a machine, but if the parts necessary be few, the information is simply recorded on the original order and returned with the office copy, to the order department. The four copies of the order are then taken, the information filled in the body of the order, the possible date of shipment ascertained (the clip showing the date is indicated on Form 1) the acknowledgement is mailed

to the customer, the works manager's and shipping clerk's copies are sent to the proper persons, while the office copy is filed alphabetically in the order department, in a place which we can call the "live-order" file. In connection it might be said that the possible date of shipment should not be decided upon until after the matter has received the attention of those competent to know regarding the time the materials can be shipped. This is of the utmost importance, and the proper handling of shipments will be the subject of the next and last article of this series.

As the orders are being made, a number of copies of the "list of material" should be typewritten—one for the works manager, one for the assembly department, one for the foreman in charge of the machining department, one for the benefit of the stock and shipping clerks, one for the order department—to be used by the cost department in entering cost data during process of construction and finally filed away by this department—the original from which the copies were made being filed in the drawing room as their record.

So far we have given notification regarding work to be made as well as the necessary information to complete the work, but no direct authority has been given to process or assemble, which cannot be done until it is known in what condition the stock of materials is in. What must be known is:

1.—What is in stock finished ready for assembly.

2.—What is in stock in the rough.

3.—What must be ordered which when received will be ready for assembly.

4.—What must be ordered which when received will have to be processed.

The stock clerk therefore takes the office list which accompanies his list, checks through his stock, and in the check columns uses the following symbols to designate the condition the order is in.

✓✓ Covering parts under classification 1.

✓ Covering parts under classification 2.

Ⓥ Covering parts under classification 3.

Ⓥ Covering parts under classification 4.

The office list is then returned to the order department along with requisitions for material needed, Form 2, and here the information concerning the condition of the stock is transferred to the list for the assembly department, the requisitions being turned over to the purchasing department where the necessary material is ordered.

The order department then takes Form 3 and makes an order in duplicate for the assembly department to cover the assembly work.

PRODUCTION ORDER				FINISHED / ROUGH
PRODUCTION ORDER No. 1160.57	PIECE No. X 450	DRAWING No. 3345	MATERIAL Steel	TO BE COMPLETED
DATE OF ORDER. 5-10-7	FOR ASSEMBLY ORDER No. 1160 Abbott			COMPLETED 6-10-6
QUANTITY	DESCRIPTION			
50	Guide Heads			

NOTE: Execute this order, returning same to factory office upon completion of the work. Charge all labor and material to the above Production Order Number.
When this Production Order covers the assembly of a machine, charge "labor" only to the Production Order Number.

Burke FOREMAN

The Eng. Magazine

FORM 3. PRODUCTION ORDER; FACE.

sending the original to the foreman, duplicates being filed in the office, after which orders are made for all parts marked as in stock in the rough, or as needing to be processed upon receipt, sending the originals of the former class to the foreman of the machining department, the duplicates being filed in the office; on the reverse side are posted the cost data secured from the daily reports turned in by the workmen, these duplicates being filed either by consecutive numbers of

Assembly				Boring				Turning				Forging				Milling				Planing				Drilling			
Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.
Threading				Grinding				Babbitting				Laying Out				Cutting Off											
Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.

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FORM 3. PRODUCTION ORDER; BACK.

orders or by part symbols as best suits the conditions, for we have the "list of material" showing the order number and the name of the customer or the purpose for which the work is being done, and we have the official notification, Form 1, which is filed alphabetically, so that any reference or cross reference is facilitated. The original and duplicate orders covering the material which must be ordered and processed upon receipt are held in the order department, in a place by themselves, pending the receipt of the materials, so that the machining department receives orders to process only such parts as are in stock. This file we will call the "reserve-order" file. Form 4 is made out at the same time as Form 3, and being sent to the stock clerk for attaching to the parts when they are issued will show the workmen what is wanted; in no case should these tags be removed until the work is safely on the assembly floor, after processing.

WORKMAN'S ORDER TICKET.			
PRODUCTION ORDER NO. 560.301	PIECE NO. BB680	DRAWING NO. 3340	MATERIAL C. I.
DATE OF ORDER 10-20-6	FOR ASSEMBLY ORDER NO. 560		
MATERIAL TO GO TO {WORKMAN / ~~MACHINE~~} NO. 31 NO. 20 NO. 101 NO.			
100 Bracket Bores			
WHEN MACHINE WORK IS FINISHED, DELIVER TO Stock Room			

The Eng. Magazine

FORM 4. WORKMAN'S ORDER TICKET. MADE IN TAG FORM FOR ATTACHMENT TO WORK.

As yet however, no material has moved, although we have provided for handling it as fast as it may be issued. In the first place, the assembly department knows from the list what parts are necessary to complete the order; it is also known from the checking what parts are available as finished stock for immediate assembly and what parts must be machined before they can be assembled. The assembly foreman knows, if he is familiar with the product, in order that assembly may be facilitated:

The finished parts needed first.

The rough parts that need machining first.

In order to start the work, and that his department may operate to the best of advantage, he fills out Form 5, for the important fin-

ished parts he needs in order to begin the assembly, making other lists as fast as he needs other finished materials, these lists being sent to the stock room. To get the parts needing machining, he uses Form 6, sending to the machining department the slips covering those parts he is most in need of, the balance being sent to the stock room. It is therefore evident that the stock and machining departments know what the assembly department is most in need of at all times and can be governed accordingly, and while the stock clerk is delivering the finished parts called for, the machining department is making out requisitions for the rough parts, using Form 3 as the authority for so doing, taking into consideration the requirements of the assembly department as evidenced by their requisitions for finished parts. The stock clerk also sees to it that the requisitions from the machining department marked with the cross in the circle, which cover the parts wanted first by the assembly department, are promptly attended to.

FINISHED PARTS

Deliver to _____ floor, for Assembly Order #____ the following finished parts which are needed by my department at once.

#	Piece	Drawing	Mat'l	Name	Order	Date Del.

Date Foreman Date Stock Clerk

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FORM 5. ASSEMBLY DEPARTMENT'S ORDER FOR FINISHED PARTS.

After the stock clerk has delivered the parts wanted first by the machining and assembly departments—after the machining department has begun work on the parts the assembly department is most in need of —the balance of the orders can be worked in as convenient; at any rate, we have prevented, by some such method, giving to the assembly and machining departments, on the start, materials which are not necessary until toward the end of the work while material that is urgently needed is not sent in or processed until the assembly department finds that it cannot go any further until the parts are in hand that should and could have been ready on the start. As fast as the stock clerk delivers material to the assembly department, requisitioned by Forms 5 and 6, and to the machining department by Form 6, he sends the slips to the order department. This is also done by the machining department when material covered by requisitions from the assembly department is delivered to the assembly floor.

MATERIAL CARD.

PRODUCTION ORDER NO.	PIECE NO.	DRAWING NO.	MATERIAL
125.43	X 4320	2640	Steel
DATE OF ORDER 5-30-6	**FOR ASSEMBLY ORDER NO.** 125- McKinney		
DELIVER MATERIAL TO {WORKMAN} {~~MACHINE~~} **NO.** 30			

10 Armbrackets- to be finished standard.

Drill 6/3/6
L. & P. 6/8/6
Finished Stk 6/10/6
Assembly 6/12/6

⊗

When properly dated and signed by Foreman, this card becomes a Requisition for Material. It becomes a Material "Delivered" card when dated and signed by the Stockkeeper, who, after signing, will place weight on back and return it to office.

DATE	FOREMAN	DATE	STOCKKEEPER
6/2/6	Jenkins	6/9/6	Smith

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FORM 6. MACHINING DEPARTMENT'S ORDER FOR PARTS SPECIALLY NEEDED.

If the assembly department could use the output of the machining department as fast as parts are finished by it, the proper course would be to send all work to the former department; but this cannot be done in the majority of cases for the reason that the assembly floor would soon be so littered up as to make it almost impossible for the workmen to turn around, and as we have a place for the storage of parts (the stock room) the most logical plan is for the machining department to send all completed work to the stock room with the exception of the few parts that are of importance in the eyes of the as-

sembly department. If we made it a rule to send *every* part to the stock room, we would perhaps be treated to the spectacle of seeing a trucker take a piece of finished work to the proper location in the stock room, unload it, be informed that the assembly department wanted it immediately, load it, and take the part to the assembly floor —considerable unnecessary work. The better and more efficient way is as above outlined, for the order department will know from the signatures to Form 6 whether the part that went to the assembly department came from the stock clerk or the machining department; but before this latter department can deliver a finished part it must know *where* to deliver it, and no trucker must take a part unless the ticket attached shows where it is to be taken. The rule is simply this: all parts go to the stock room except those covered by the requisitions from the assembly department, so that it is an easy matter for someone delegated to look after this particular part of the work to check assembly-department requisitions against the work, marking at the bottom of the workmen's ticket where the parts are finally to go.

It is the duty of the order department each day to check over the receiving clerk's list of receipts, so that if any material has been received against which there are orders in the "reserve-order" file, they can be released and the machinery started so as to get the parts through the machining department and to the stock room or assembly floor. The stock clerk has the requisitions from the assembly department covering parts which, while not needing processing, were not in stock, so that as fast as material arrives, it will be issued by him without delay.

The most important consideration now is: *where are all the parts after an order has been started and under way, and what shape is an order in at any one time?* Any manufacturer who is in a position to answer this question intelligently is on the road to getting everything out of his business that is possible to get. Reference to Form 6 will show that after signing by the foreman and previous to delivery, it is a "requisition" for material; but as soon as the material is delivered and the stock clerk affixes his signature, the slip indicates that the material has been "delivered" to the machine or workman specified. From this slip we know that on June 3, Smith the stock clerk delivered ten arm brackets to workman 30—drill department, as requested by Jenkins the foreman, and as the order department receives this slip right after the stock clerk signs it, the department has a means of knowing *when* these ten parts were issued as well as *where* they were delivered. If we file this slip against the drill department, we really charge it and credit the stock room for the

MATERIAL RECEIPTS

We have just received from the Drill Department, the list of parts below described

#	Piece	Drawing	Name	Order
10	X4320	2640	Arm Brackets	125.43
3	B60	2120	Posts	160.82
5	X342	1080	Cylinders	130.45
20	Y 20	4080	Caps	420.5

Date 4/8/6 By Wilson Department L. and P.

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FORM 7. RECEIPT FOR MATERIAL PASSING BETWEEN DEPARTMENTS.

parts, for these slips are used as authority for posting to the stock cards (Form 4, page 236, THE ENGINEERING MAGAZINE, May, 1908). When the order department has done this with all of the "material cards," it has in its possession a means of advising anyone who wants to know just where any part is—*providing the part is followed from place to place in some way.* This can be done by using certain in-

formation and having in the Order department a file of drawers where these slips, Form 6, can be filed.

This information comes from different sources. In the order file, we have the "reserve orders" for which there is no material—we have the lists of finished parts, Form 5, which the stock clerk has delivered to the assembly department, and we have the requisition, Form 6, which comes from either the stock clerk or machining department as the case may be. A form of receipt is used to cover the materials passing *between* the departments of the machining department, Form 7, these being sent to the office when one of these departments receives material from another. The importance of this cannot be overestimated as it places each department on its own feet, each one checking the work of the other as well as fixing responsibility. The machining department and the stock room require no receipt from the assembly department for the reason that the requisitions for material are "delivered" slips after materials have been delivered, and are virtually equivalent to receipts. This is our fourth source of information, the fifth and final one being a daily list of receipts from the stock clerk covering finished parts received from the machining department. This knowledge is valuable and on tap so that manipulation is the only thing necessary to be able to furnish information concerning the work under way.

Take, for instance, Form 6. Upon receipt of this slip from the stock room, the clerk, who knows that Jenkins is in charge of the drill department, marks in one corner—"Drill, 6/3/6," as shown, and files in the drawers above mentioned back of the guide marked 125, the arrangement being numerical. On the 8th, a receipt, Form 7, comes from the Lathe and Planer Department, the first item being the ten arm brackets, order 125.43. The clerk then removes the slip, Form 6, from its numerical place and marks "L. and P., 6/8/6," placing it back in its position again. On the 10th, a list of receipts comes to the order department which contain this item of ten arm brackets, and the clerk then marks on the slip as is shown in the illustration. It is again filed where it remains until the assembly department requisition for these ten parts is received from the stock clerk, dated the 12th. The slip is marked to correspond, and filed with the assembly-department slip, for future reference.

It is therefore evident that any reference to 125.43, ten arm brackets, will show the condition of the order at any time after the material was delivered. Applied to all orders, it follows that the drawers, the "reserve-order" file, and the lists sent to the office by the assembly department through the stock clerk, will show at all times the condi-

tion of any order; the value of this cannot be everestimated, and while a casual reading would seem to indicate that the method is too complex to be practical, consideration will show that this is not the case. It needs or should need no argument to convince a manufacturer that material should not be delivered anywhere without a record being made of the transaction, either in the form of a receipt or requisition, and that the stock clerk should make a list of all the materials he receives from the machining department, as the receiving clerk does for all materials received from outside. The information serves a purpose in itself, but why not go further with it? What would do more good than an arrangement whereby this information can be used to inform anyone regarding the condition of orders, especially when one considers that a few hours each day will do the work, and that in a plant of any size, where a number of machines are being built—the parts numbering into the thousands—if regular and stock orders are considered, it is out of the question to expect any one man or group of men to *know all about every part of every order at all times.* Provide some means of informing them regarding the progress of the orders and the location of the parts, and they are then in a position to take advantage of the information for they will know how to proceed to a desired end, as the following will show.

If the works manager wishes to "get after" an order, he gives his "list of material" to the order department, with instructions to advise him regarding the condition of the various parts. These parts are either on the assembly floor, in the lathe and planer, drilling, or milling departments, in the stock room as finished parts received from the machining department and awaiting requisitions from the assembly department, not as yet withdrawn from stock, while some of the material necessary to finish the order may not have been received by the stock department. The order department adopts the following symbols as indicating the condition of the parts:

W.—Orders waiting for material.
A.—In Assembly Department.
M.—In Milling Department.
D.—In Drilling Department.
L.—In Lathe and Planing Department.
F.—Finished parts in Stock Room ready for assembly.
N.—Parts not as yet withdrawn.

The clerk can turn to his file or orders waiting for materials and place a letter W in the √ column of the "list of material" for parts whose numbers correspond to the numbers of the parts on the list. He then takes the list from the assembly department, Form 5, prefixes the

letter A for parts in the assembly department, after which he refers to the drawers where the slips, Form 6, are filed, and checks each one covered by the order number in question against the list of material. After he has done this he will have a number of parts against which there are no check marks which must be the parts that have not been withdrawn from stock up to time the list is checked, these parts being marked with a letter N. When the works manager again gets the list—and this process can be repeated as many times as desired—he knows the exact condition the order was in up to within a short time previous to the checking, and even if the list shows a piece as being in the drilling department that has gone on to the milling department no harm has been done, for he knows *where to start* his investigation, which is far better than to have no definite point from which to begin. If on the other hand the works manager or any of the foremen desire to know concerning any part, the file in the office will supply the information. As before stated, the necessary data are at hand as soon as material is delivered or transferred, and a little work will put the information in shape for use whenever needed. There is a difference between having information in every conceivable shape and having it properly classified and on tap for immediate reference.

Further information is at the disposal of the shop management in the shape of the daily time cards turned in by the workmen, all time being posted to the reverse side of the production order each day. Reference to the orders covering parts or to the orders covering assembling work will therefore show how much time has been consumed on an order up to the day previous to the reference. The clerk furnishing the works manager with information regarding the condition of an order, by turning to the file of live production orders, when checking through the various parts that are in the machining department, can mark opposite these parts:

T.—Time recorded.

N.—No time recorded.

This will show him not only where the parts are but whether they have been worked on or not, and through the information furnished him he can plan for maximum production under the best conditions, for once he knows the shape an order is in, personal effort will do the rest. He will want to make certain demands on certain departments after he knows what work is to be given preference over other work, using Form 8 for this purpose.

The scheme of numbering here shown will facilitate investigation. A large number of concerns have a series of numbers to cover the

various orders for machines and another series of numbers covering the parts of a machine. For instance an order for a certain machine might be No. 3,140 while the first part might be No. 11,908, the second part No. 11,909, etc. It is evident that in looking up an order there is no such connection between the two series of numbers as in the case of the method advocated above. An order for a machine may have 250 as its number, while the first part would be 250.1, the second part 250.2, the third 250.3, etc. As soon as the order gets under way, the workmen know that the parts are for order 250 and the assemblers will soon fix 250 in their minds, so that when it is desired to follow

WORK WANTED AT ONCE

To the Foreman of the_____ Department. The following orders are urgently needed. Give them preference over all other orders _____ W.M.

Order	#	Piece	Drawing	Order	#	Piece	Drawing

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FORM 8. REQUISITION FOR URGENT WORK.

up an order, any person looking for the parts that go to make up 250 will have no great difficulty in finding them.

A workman should always have at his floor the material that he can commence upon as soon as he finishes the job on which he is working. For a man to finish a job, go to his foreman for another, and then wait for the material, certainly does not assist in making dividends for the manufacturer. In a large number of plants the work is such as will admit of a "job ahead" plan, which is in successful operation in a number of enterprises. The system can be used

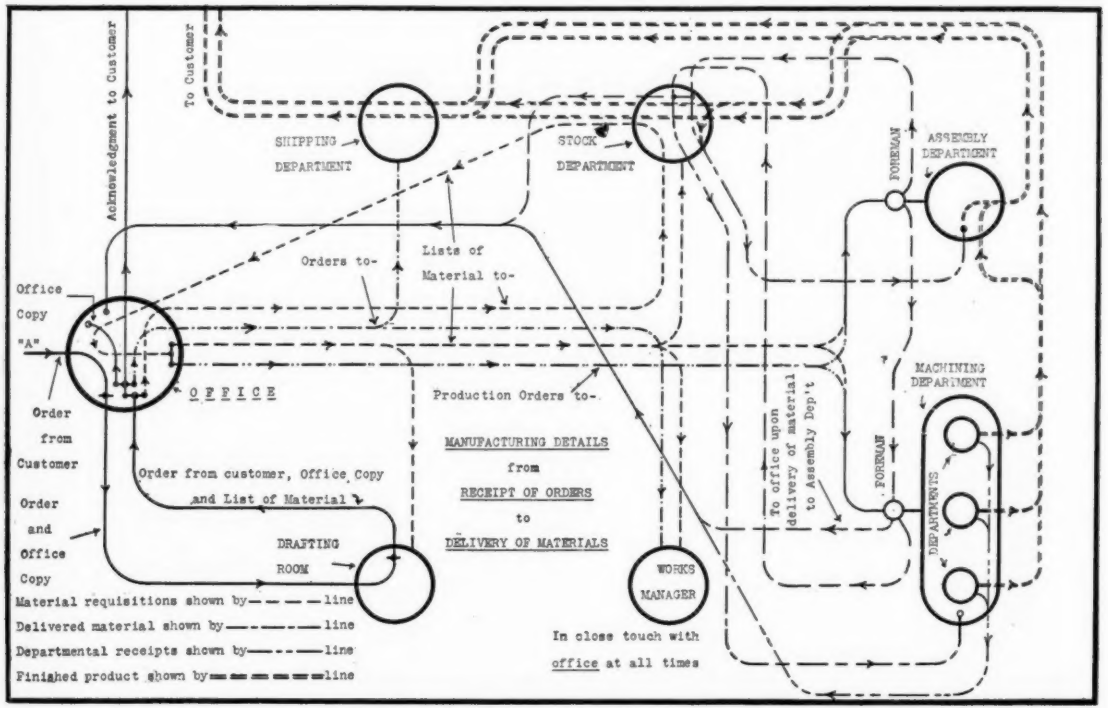

Acknowledgment to Customer
To Customer
SHIPPING DEPARTMENT
STOCK DEPARTMENT
FOREMAN
ASSEMBLY DEPARTMENT
Orders to-
Lists of Material to-
Office Copy "A"
O F F I C E
Order from Customer
Order from customer, Office Copy and List of Material
Order and Office Copy
DRAFTING ROOM
Production Orders to-
MANUFACTURING DETAILS from RECEIPT OF ORDERS to DELIVERY OF MATERIALS
To office upon delivery of material to Assembly Dep't
FOREMAN
MACHINING DEPARTMENT
DEPARTMENTS
WORKS MANAGER
In close touch with office at all times
Material requisitions shown by - - - - line
Delivered material shown by ——— line
Departmental receipts shown by ——— line
Finished product shown by ═══ line

DIAGRAM SHOWING THE COURSE OF ORDERS, MATERIALS, AND WORK UNDER THE SYSTEM DESCRIBED.
To read the Diagram, start at A.

in conjunction with a time clock, by the introduction of an additional card rack which is to hold the "job ahead" tickets. When a foreman gets the production order, he knows the operations necessary to complete the work as well as the men who will do the work, so that it is an easy matter to make out the time cards for the necessary operations and place them in the proper pockets in the "job ahead" rack, at the same time sending the material requisitions covering the work to the stock room. When a man finishes the work he has in his machine, he takes his card from the "jobs in operation" rack, stamps it properly and then takes the top card from his pocket in the "job ahead" rack, stamps it, sees what work it calls for, places it in the "jobs in operation" rack; goes to his machine, finds the material ready for him, and goes to work without losing much time unless he *creeps* to the clock and back, as is often done.

To prevent this creeping, and in order to see to it that a workman accomplishes what is expected of him, some method for comparing operation time and cost should be introduced, which would enable the cost department to call to the notice of the foremen any costs that are higher than they should be. The total time and cost of each operation on each part, with the number of the workman, should be posted in such a way as to facilitate comparison with all previous work of the same kind. When a high cost is recorded it will be noticed at once and a form such as that shown on page 81 of THE ENGINEERING MAGAZINE for April, 1907, can be used as the notice to the foremen, who will naturally speak of the workmen responsible in order to give some reason for the increase in the time, the result of which will be that the workmen will soon realize that they cannot do something that their foremen will not know of, and loafing will decrease.

The assembling of certain parts into groups, to be carried in stock for final assembly, should be given careful consideration by progressive manufacturers. In the second article it was shown that even special machines may have some standard parts, and a study of the product would show where grouping could be done to such advantage as would greatly facilitate final assembly. If we have thirty separate parts to assemble, time required to assemble being fifty hours, and by grouping certain parts it is found that only ten pieces are necessary to assemble, five pieces being groups composed of two or more parts each, as the case may be, the final assembly time will be considerable lessened; any saving in assembly time is always an object, especially when delivery is the important consideration as it often is. The work of grouping can be done in odd moments or when there is a slackening in orders, and the results of this would certainly justify the efforts.

PERSONALISM IN RAILROADING.

By H. W. Jacobs.

THE INDIVIDUAL ELEMENT IN RAILWAY ORGANIZATION.

A leading authority on industrial administration said recently that there are two great schools apparent in American works organization—the monarchical, typified by the Taylor system, in which the management does all the thinking, and orders every act of every individual producer by code; and the democratic, represented by the Carpenter system, in which individual initiative is encouraged and co-ordinated.

As a study in the science of management, Mr. Jacobs' paper is a striking contribution to the propaganda of co-operation, advanced also elsewhere in this issue by Mr. Knoeppel. On the mechanical side it suggests an interesting contrast between American locomotive practice and the Continental ideas depicted in preceding pages by Mr. King.—THE EDITORS.

AMERICA offers unprecedented opportunities for individual development—for the individual to develop the natural resources of a productive land, for the individual to reap an enormous percentage of profit by the intelligent combination and direction of collective labor.

The fundamental cause for this opportunity has lain in the American idea of government, which stands for giving each man the largest individual freedom possible. The man has not been held in check by an array of governmental restrictions, of landed and vested interests, rights and privileges, of barriers by which avenues are closed to the rise of even exceptional individuals into the "upper" and controlling strata. The "exceptional" man in America has been able to rise to positions of great power both in the political and in the industrial or commercial world. Such men are exceptional chiefly in the fact that they *use to advantage* the resources embodied in their own selves, and much less because of any special aptitude or genius—for America is relatively poor in the artists and masters of art and craft who are distinguished by such singular attributes in their special fields.

The ordinary individual possesses within himself capabilities which may be turned to great profit, if properly used; but he lacks the spring for liberating these capabilities and making them of use.

It is worth remembering in this connection that the material wealth extracted from the earth's natural resources is as old as the

hills themselves, and is given value only by the form produced upon it by men's efforts and minds.

> "But the mines of wealth to be found in every brain will, if worked, supply treasures such as have never been dreamed of. The iron and steel that make the locomotive came out of the ground, where the iron has always lain. But the idea of the locomotive itself, like all ideas that have brought humanity up through the stone age to our very imperfect civilization, came out of a man's mind.
>
> "If the men who have done the thinking for the race—and pitifully few of them there are—had been content to draw a bare living from their brains, the rest of us would now be getting our breakfast with clubs and sleeping in caves, or in the tree tops."

The very growth of the institutions which the extraordinary man has founded, however, now demands that the latent or partly inert abilities of the army of ordinary individuals shall be used to the utmost. So far as practicable, his own super-ordinary genius must be embodied in principles and systems which will endure, and may expand, while his individual mind extends its work elsewhere—or even after it has ceased to live and work at all. This is the meaning of industrial organization at its best—not the substitution of method and motive for human genius, but the expression of genius in the form of principles which ordinary men may follow, and following bring out more of their own capacity perhaps than they previously knew how to make effective.

Any movement which thus tends to impersonalize (so to speak) the individual, inevitably causes individual disapproval. Leadership is less strongly commanding, as staff or bureau organization becomes more prominent and even the rank and file rise to a certain sense of participation in result. All along the scale of authority more or less jealousy will be manifest—apprehension that individual prestige and profit may be lessened, and the autocracy of the individual hand and brain may be endangered, if others are admitted into deliberative counsel—still more, if others are admitted into co-operation in the development of any proposition.

So it is that a narrow and selfish egotism, prey to prejudice, prevents many a person from arriving at correct conclusions. Thus people are envious of the success of others, especially if that success is attained through the practical application of ideas which they themselves have entertained in a vague but unconstructive way. These people may not have the initiative, the imagination, or the practical ability and judgment to execute their ideas; but such ideas occurring to other men having the qualities of conception and exe-

cution, endow the latter with the large rewards. The lesser return is always the portion of the man who cannot make use of his ideas.

Two practical examples of this state of affairs come to mind, one taken from the history of the locomotive, and the other from a general modern business condition. Walschaert invented a valve gear of undoubted excellence when applied to locomotives. Although designed and constructed many years ago, it has remained almost unknown and unproductive until men of push and business ability, realizing the advantages of the gear, took hold of it and made it a part of modern locomotive practice. As a result the gear was given an impetus that is rapidly forcing it ahead as the principal gear for locomotive use. However, if Walschaert should return to earth today and see his gear in operation on the many large locomotives running up and down the railways of the United States, he would probably feel that he had a just grievance because he was not reaping the benefit from this development of his original idea by other progressive men, and in fact he might criticize the present designs.

The general example of this tendency is found in modern advertisement. Articles such as cigars or oatmeal in packages are sold on the open market, where there is no exclusive claim to a particular idea. These articles are widely advertised and the public practically hypnotized on a large scale into making them standards of use and believing in the merits claimed. For the privilege of using these, the public pays a sum that covers the cost of advertisement many times over. The reason for the success of these advertised articles over ordinary articles is that energy and push is used in disposing of them, and not at all that the idea of selling cigars in boxes, or of putting oatmeal up in paper packages with gay colored labels, is a new one.

Some have the quality of idealization or imagination *(einbildung)*, without the creative or practically constructive force; their ideas are still-born and fail to survive from want of ever receiving living expression; others have qualities of patience and slow persistence, bringing into real being ideas or purposes which are set before them; but few combine these qualities in successful degree, and the few that do are the leaders and masters. Most men in charge of modern enterprises, however, are not true leaders or commanders; as in our political scheme, so also in our industrial organization, the men are executives—they approve or veto, they select, they give form to and execute the ideas of the staff, of others. And so it must be; the manager must hold the welfare of the business entrusted to his super-

vision—as it may be advanced by any policy, whatever its source—above a personal egoistic valuation of his own originality; and the lesser man of the staff, who is employed for his good ideas, but who perhaps has not the other qualities essential to an executive (since he has not earned the managerial position), should welcome and be glad in the opportunity afforded of having his ideas elaborated into concrete, living, useful daily realities, rather than stand one side and think "I, I contrived this thing, but others, because they have money to employ me, get the credit and the benefit."

The value of ideas lies in the ability to use them constructively and to execute them. Day-dreams are generally of less value than the time spent in building them.

In industrial enterprises—manufactories, shops, transportation companies—the sympathy and co-operation of the foremen and others most immediately directing the actually productive labor, is most essential for the successful introduction and application of progressive and useful ideas and methods.

I have known foremen and engineers, who, when it was first sought to introduce improved methods and devices or advanced types of locomotives, *thought* it was their duty to try to defeat the object of these devices and new designs by failing to run the jig or to operate the tool and engine to their best advantage. This is destructive criticism of the worst type, because it cheats those who employed these men, as well as because it is dishonorable to those engaged in putting these tools and ideas into effect.

In the motive-power operation of a railroad, a road foreman of engines, more than any other man, should be the evangelist among engineers and expound the new methods of progress, and like other reformers, should be able to paint with a broom the object to be attained.

An engineer on the road should be as supreme on his engine as a captain on his ship; undoubtedly it is true that many "engine failures" are due to the fact that in some cases enginemen are directly opposed to the shopmen and their work, even being encouraged in such an attitude by some of the officials, such as road foremen of engines, to report engines for unnecessary work, in order to burden the shop men needlessly, or to show a disposition not to assist in keeping an engine going when some defect develops, so as to throw the blame for this condition upon the shop men.

It is a road foreman's duty to criticize and to have corrected any improper work done in the shop. No one who is not supersensitive

objects to criticism that brings out weak spots in any method or plan, as criticism of this kind is far more helpful than undue praise which makes a man feel that he could not make a mistake if he tried. There is also a kind of criticism which helps neither the giver nor the recipient; the kind that is destructive, and not constructive in the least. True, it may set the originator thinking that perhaps a certain point may be improved, but there is no hint of the critic's ideas on the subject, nor indeed whether he has any. It is one thing to look over an innovation, such as a method, or tool, or practice, and to give out the uncalled for statement that it is "not as it should be," or that "one would not have done it in that way"; and it is a very different thing to be presented with a problem and to be asked to devise a method of putting it into effect and practical operation. In many cases, the critic has offered no suggestions in the beginning and only condemned the work that has been put into practice to show that he knows that it might have been made or done differently. The conception and putting into effect of tools, methods, or practices requires a certain amount of imagination, which is a quality that is lacking in a critic of the destructive type. He can see a method after it has been thought out and put it into effect, and he gets the idea that a difference here or there might be better; but when it comes to creative criticism, making a suggestion of value, the destructive critic is all at sea. The constructive critic, on the other hand has suggestions for improvement that are real, points out ways and means of making desired changes, and is a real helper rather than an irritating fault-finder.

Then there are those who oppose new policies, but who do not openly object to them. These men in referring to some advocate of an improved method will admit the man's brilliance, or ingenuity, or peculiar ability, and will follow up this apparently friendly attitude with an apology (indulgent perhaps and a little patronizing) for some supposed weakness of character, bad habit, incapacity, religious belief, of the person under discussion, couching the expression in such terms and selecting the particular defect that is to be enlarged upon in such a way as most to appeal to the prejudices of the hearer.

Equally restrictive to the introduction of any new device or system on a railway is the extreme element of conservatism that has such a stronghold in the minds of the average railway official, from the heads of departments down to the foremen, and even to the men in the shops; a conservatism fostered by years of unbroken habitude, and firmly established by following devoutly the recurrent routine

of daily duties. From this conservatism itself, coupled with a fear of disapprobation should a mistake be made in the adoption of some method or device differing from the old and established *régime*, springs a destructive criticism which, though it may be given with the object of self-protection, often results in an irreparable loss, both to the object of criticism and to the criticiser.

Most railroads are continuing to use almost exclusively the simple engine of half a century ago, modified only in its size and power, but employing the same essential design; and American railroads have been behind other engineering progress in questions relating to the mechanism of their locomotives. The marine engine had its real development during almost the identical period in which the steam locomotive has so potently changed the face of the land and the destinies of its denizens. "Fulton's Folly" was a simple slide-valve engine operating upon a transverse shaft—and the locomotive of today is little more. But the marine engine soon turned to the screw propeller, soon adopted the economical compound cylinder type (largely stimulated by experiments in the United States navy), further extended this principle to the use of triple and quadruple expansions, of twin, and quadruple screws, and has lately adopted the still more efficient and facile steam turbine. And the art of marine motive power will not stop here. Already plans are seriously discussed looking to the application of some form of gas or oil internal-combustion motor on shipboard; indeed these motors already propel the swifter, cheaper, and more convenient power boats of smaller size.

What parallel to this can the railroads show? True, in fifty years our locomotives have increased from thirty tons to two-hundred and ninety tons, total weight, but in the same period steamships have increased from eight-hundred to forty thousand tons displacement, and marine engines from three hundred to seventy-thousand horse power. But where the compound engine was early adopted on shipboard from reasons of economy of operation and space occupied per power unit developed, those reasons, still more important in the narrow confines of rail traffic, have not until recently been effective in railroad circles in America in making a success of the compound locomotive.

There is nothing the matter with the compound locomotive; the only trouble with the use of these engines in the United States is that they require a greater attention, a greater detailed supervision of their finer mechanism, than is the case with simple engines which

are cheaper to build, perhaps cheaper to maintain (though not on a performance-unit basis) and certainly less efficient in the use of power and in the haulage of loads.

As proposed by one engineer, we should have today, instead of simple engines and boilers whose greatest efficiency is demonstrated to be at about 180-pounds pressure, boilers of the automobile or sectional type operating at from 400 to 1,000-pounds pressure, superheated, and turbo-generators transmitting power to all wheels of the locomotive unit through electric motors; possible even we should have gas engines, driving through a similar electric arrangement or through a mechanical transmission.

Taking their cue from the remarkably successful street-railway installations, some steam railroads are making a fair show of adopting electricity direct as the tractive force, but it is very evident that this will prove economical, as compared even with crude steam-locomotive traction, only where the very densest traffic produces such continuous use of facilities and resultant revenue as to return a sufficiently large figure on the very costly improvement. Probably an internal-combustion motor using producer gas or fuel oil would, if worked out, prove more efficient.

Since the advent of the common spike years ago no important steps have been taken to replace a device admittedly wanting in qualities most to be desired in a spike—holding power and preservation of the tie; yet the common nail spike has such a firm place in the minds of the conservatives that it is only recently that the screw spike has received any attention, though admittedly the screw spike is far superior to its competitor in every respect, as its extensive use in Europe, where lumber is dear and labor cheap, had demonstrated conclusively.

There are many other examples easily called to mind which only serve to bring out more strongly this element of conservatism. The old adage of "Let well enough alone" has long been a slogan on the American railway, but is fast losing its convincing power. One can almost distinguish with clearness a dividing line springing up among the employees of American railroads—the old and new blood, the man whose convictions are not to be modified and the man who is "willing to be shown."

An analyst of railroad conditions while speaking of the application of intelligence and methodical system to the problems met in the course of ordinary and extraordinary experience, and the influence they may have in improving the workaday opportunities, has aptly said:

"A better and more expensive engineer was needed to stop the flow into the Salton Sea when the break had been made than is needed to keep the Colorado River where it belongs now that the break is closed. Sensational work, such as damming the Colorado River, putting a ship off the rocks, or keeping engines going after they are in such shape that every one is looking on, is more exciting and pleasing than plodding along the systematic, detail daily work. Systematic detail work keeps everything going properly, but cuts out the chance of having the lime light thrown upon the performer.

"This element of pride and self-glory makes the ordinary man of authority plant his feet and balk when system is proposed. He wants to do everything himself and get all the glory. If record and system are applied he feels that a set of clerks will do his work. He knows that if system is applied rigidly enough the proper course will be as plain as the channel into a harbor marked with lighthouses and buoys. Columbus is more of a hero than the sea captain of today who courses the ocean with charts, lighthouses, and buoys which mark the channels through which the man in authority should sail his affairs. This man, however, realizes that his personal glory dwindles when he sails in charted seas. Hence he says: 'No system for me.'"

Of course it is apparent that the thing for such a man to do is to seize the opportunity and make charts where there are none, so that not only will he more certainly and swiftly arrive at his objective port, and avoid treacherous shoals and reefs by the way, but also achieve the distinction of providing charts where there was only wind and water before, and of piloting the way for the more timid who follow.

PIPE-LINE REFRIGERATION.

By Jos. H. Hart.

PIPE-LINE refrigeration on a large scale was confidently predicted as a development of the near future, by the majority of the engineering profession, soon after the advent of mechanical refrigeration as a commercial process and the recognition of its status as a commercial convenience. Time has passed, however, and to the great majority of engineers pipe-line refrigeration still looms very remote in engineering progress, at least as a general and universal service. It is the object of this paper to consider more especially what progress has been made, to enumerate the difficulties encountered and the possibilities of their removal, and to give a brief *résumé* of the entire situation.

Pipe-line systems producing efficient refrigeration are in actual operation today in a fairly great number of the larger cities, and in some cases have been in use for over a score of years with very satisfactory results. In order to understand the limitations in this practice and the reasons for lack of further progress, a complete understanding of refrigerating engineering would be necessary; but a few of the main features and difficulties will be at once perceptible in the majority of cases, and will lead rather to surprise that the development has extended as far as it has. Pipe-line refrigeration exists in the following American cities:—Boston, New York, St. Louis, Atlantic City, Baltimore, Norfolk, Los Angeles, Denver and Kansas City. The length of mains installed varies from one mile to seventeen miles, and the commercial status of the systems varies from a very lucrative one in several of the plants to the direct opposite in Denver where the operation has been discontinued. The refrigeration in every case is used to cool cold-storage plants, chambers in hotels and apartment houses, restaurants, and the shops of a few small dealers whose consumption is yet several times larger than that of the average dwelling It has been found very inefficient to attempt to produce refrigeration in smaller units than about 500 pounds per day—that is, refrigeration equivalent to the melting of 500 pounds of ice per 24 hours.

The refrigerating plants in such installations have invariably been of the ammonia type, and in the selection of the latter the absorption system has been invariably used on account of mechanical considerations purely. Only two methods have been employed for distribution—brine-circulation and direct-expansion. The brine-circulation is much the older of the two methods, but is generally considered the more inefficient, and the direct-expansion has been installed in all the recent systems.

Pipe-line refrigeration is a very attractive proposition to the average cold-storage or ice manufacturer, since he invariably increases his refrigeration output and consumption, with diminution in fixed charges due to the utilization of the refrigeration outside of his own building; but even so, the progress has not been rapid. Brine circulation requires the laying of two mains, an outgoing and ingoing pipe for the cold and warm brine respectively. Direct expansion, on the other hand, requires the installation of three pipes, one of these (the liquid-ammonia pipe), being invariably a heavy-pressure pipe constructed to withstand severe usage In the brine system the brine is cooled by the evaporating ammonia in a system of coils or shell cooler, and is then piped through the circuits. This process is simply an hydraulic one and no serious difficulties from a theoretical viewpoint are encountered. However, the loss in refrigeration due to radiation and the difficulty of regulating the flow of brine through units of various sizes arranged in parallel, is considerable and ultimately limits the expansion of the system.

The direct-expansion system, on the other hand, sends the liquid ammonia through the piping, under pressure, to the expansion valve situated at the point requiring refrigeration. Here the evaporation occurs and the refrigeration is produced, and the vapor is there drawn back through the return vapor pipe into the cylinder, where it is, in turn, compressed. Owing to the presence of air in the circuit to a greater or less extent, it is necessary to have a third pipe connected with each unit immediately beyond the expansion valve in order to remove the air. This pipe in turn serves the further purpose of supplying in sections an alternate channel for the return or outgo of ammonia in case any part of the circuit or any refrigerative unit requires special attention on account of breakdown or leakage. The great stresses to which both of these systems are subjected on account of temperature variations, requires that they shall be laid with great care, in hollow conduits with expansion joints and on account of the heavy pressure in the supply pipe, connections are made only at

stated intervals through man holes, generally at the intersection of cross streets. The direct-expansion system, while eliminating to a certain extent the loss of radiation in transit of the cooling material, involves a number of mechanical difficulties extremely hard to overcome. The liquid ammonia must always be kept under sufficient pressure to remain liquid. On this account it cannot be raised any great distance in high buildings, on account of hydraulic pressure acting against the machine, and considerable grades cannot be negotiated. In addition there is a distinct friction loss in the pipes, and this has been sufficient in some cases to allow of gasefication of the ammonia in the supply pipe. On the other hand, in the vapor pipe the friction loss is very great; and a sufficient head can be maintained at the terminal to withdraw the vapor from the cooling coils with sufficient rapidity to produce satisfactory refrigeration there, only by lowering the suction pressure to an extent which renders the operation of a compression system absolutely impracticable.

The absorption system, utilizing the absorptive power of water for ammonia gas and the loss of this power with rise in temperature to produce the liquid ammonia and remove the vapor, operates efficiently at a much lower suction pressure than is possible with the compression type. Hence the absorption system only has been installed in such developments. Under these circumstances it can be readily seen that the difficulties met with in the direct-expansion systems are very great. The direct-expansion system has superseded to a very great extent the brine circulation as in practice it has proved more efficient. Certain problems have been met and solved, however, in the installation of these systems which will permit of their more rapid development in the future. Thus a pipe-line system, in order to be a commercial success and operate efficiently, can never handle freezing business. It is limited exclusively to the production of mild refrigeration, owing to the weak back-pressure available with low temperatures and the unequal distribution of the ammonia evaporation when it must be maintained at different pressures in the several refrigeration boxes. Again, it has been found that pipe lines must be above suspicion as far as leakage between manholes is concerned, since the loss of ammonia and its re-supply will make a big difference between profit and loss in the operation of the plant.

In the brine system moisture is an ever-present difficulty, and in the Atlantic City plant the presence of moisture in the form of salt water and electrolysis due to stray currents all present difficulties in the maintenance. The joints between manholes are made fairly

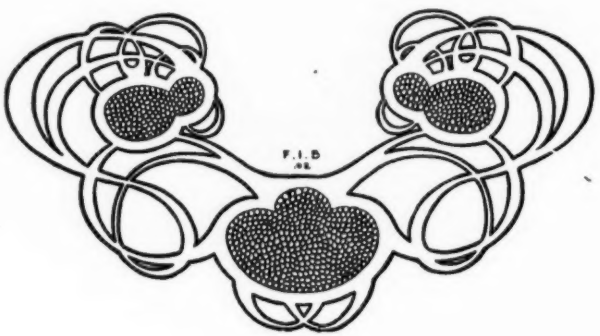
tight today in the direct-expansion system by the use of thermit for direct welding; but the cost of installation is still great. The cost of construction of the city mains will be about $4 per lineal foot with the vapor line 4 inches, and laterals will cost 75 per cent. of this. Hollow tile with concrete base must be used and allowance made for expansion and contraction without undue strains. Outside of a congested district in the city of Boston, and one or two isolated lines where the length of mains is abnormal, the average gross income is about $12,000 a mile. Boston and New York have both the brine-circulation and direct-expansion systems installed in two separate operating units. One of the Boston plants cools approximately 600 refrigerating boxes with a total space of 1,500,000 feet. This is one of the largest systems and one of the most complicated.

This constitutes the situation in regard to pipe-line refrigeration in the United States as it exists today. Undoubtedly progress will be comparatively slow and the dream of the average refrigerating engineer, that central-station plants will supply refrigeration to all the inhabitants of the city at reasonable rates, will not be solved in the near future (if ever) by the expansion of either of these systems. Engineers are beginning to realize this latter fact, and one or two possible changes or new developments are promised for the near future. Cold-air refrigeration by utilizing balanced expansion and obtaining cold air by the performance of work is not an efficient refrigerating process. It is used, however, to a very great extent in England, even in large units, and has been reasonably satisfactory. It is also used on shipboard and is in use in some special refrigeration systems in transportation for the conveyance of perishable products. Thus the method while not as efficient in individual units as a corresponding ammonia system, still is not so inadequate that it cannot compete under special local conditions. A compressed-air plant produces refrigeration when the air is used to do work, and in many cases the exhaust from an air-driven engine will clog up with ice formed from the moisture present in the atmosphere. The compressed-air plant of Norwich, Conn., which supplies compressed air produced by hydraulic air compressor to the entire town through a system of mains, has recently developed a machine for the production of liquid air from the exhaust of the average air-driven engine. Such a refrigerating system for pipe-line service would consist simply of a single line of pipe supplying compressed air at normal temperature. A small machine utilizing this air for work in the production of electric light for the dwelling or building could

then turn its exhaust into a refrigerating chamber, and after that could allow it to escape into the atmosphere. Thus, such a system constructed on the above lines would be simplicity itself as far as the details of pipe-line construction and operation were concerned. The air pressure need not be great for mild refrigeration, and its advent is probably dependent only upon the development of a more efficient and satisfactory air compressor than the modern reciprocating type. The rotary air compressor will probably find a new field waiting as soon as it becomes an efficient practical machine.

Again, absorption-machine manufacturers and designers are considering the separation of the absorption machine into two separate units, the liquid-ammonia producer existing in the central power plant, the absorber and the cooling coil being placed at the point where the refrigeration is required. Under these circumstances liquid only would go through the pipes—liquid ammonia, weak and strong liquor respectively—and the difficulties met with in diminution in pressure of the vapor through friction loss and variable supply from different points would not be as severe.

Sufficient has been said to show the main inherent difficulties of the present installation of pipe-line refrigeration, and to show further that probably some new movement is necessary for any great extension of this engineering process. That such developments will undoubtedly come along lines herein mentioned is also a foregone conclusion, but the rapidity with which these will occur will depend largely upon the external influencing conditions.



STEEL-RAIL BREAKAGES. QUESTIONS OF DESIGN AND SPECIFICATIONS.

By Harold V. Coes.

In the following pages Mr. Coes treats of a subject which is attracting international attention—the frequency of rail breakages on the railroads of the United States and the increasing number of disastrous derailments due to this cause. While his point of view is primarily that of the consumer, his summary of, and comments on, the questions at issue between manufacturers and consumers are entirely non-partisan in spirit. The discussion will be continued in a subsequent issue by Dr. G. B. Waterhouse who will present the view of the situation taken by the manufacturers.—THE EDITORS.

THERE has been a great deal of discussion of late as to the causes of the increasing number of rail breakages, particularly apparent since the advent of the heavier-section rails. It is the aim of this paper to compare impartially the arguments pro and con and the facts as presented by both manufacturer and consumer.

Neither party can controvert the facts as presented by the Report of the New York State Railroad Commissioners. The Commission's figures show that during the three winter months January, February, and March 1905, there occurred 1,331 breakages, 826 for the same period in 1906 and 3,014 for the same period in 1907. When reduced to breakage per mile of main track (including all trackage except sidings, yards, and turnouts) the figures show that there was on an average, one breakage for every 7 miles of the 9,474 miles of main line in 1905, but that in 1907 the figures had more than doubled, showing one breakage for each 3 miles.

Chart I gives the graphic relations of age to frequency of fracture. This curve shows that by far the largest majority of rail breakages develop during the first year of service. In fact, for nearly 500 breakages per year of rails one-year old there are but about 50 breakages of rails ten-years old. The curve has an upward tendency after the fifteenth-year point is reached, which checks very well with the known facts as to the average life of steel rails.

Chart II shows the relations between the weights of rail in pounds per yard and the total number of breakages. It is seen at a glance that the heaviest sections commonly used produced the largest number of breaks. Thus the 80-pound rail shows 719 breakages in 1905, the 90-pound 324 in 1906, and the 100-pound 1,295 in 1907.

Chart III is plotted with the above data, omitting all sections from Chart II excepting the 80, 90 and 100-pound section.

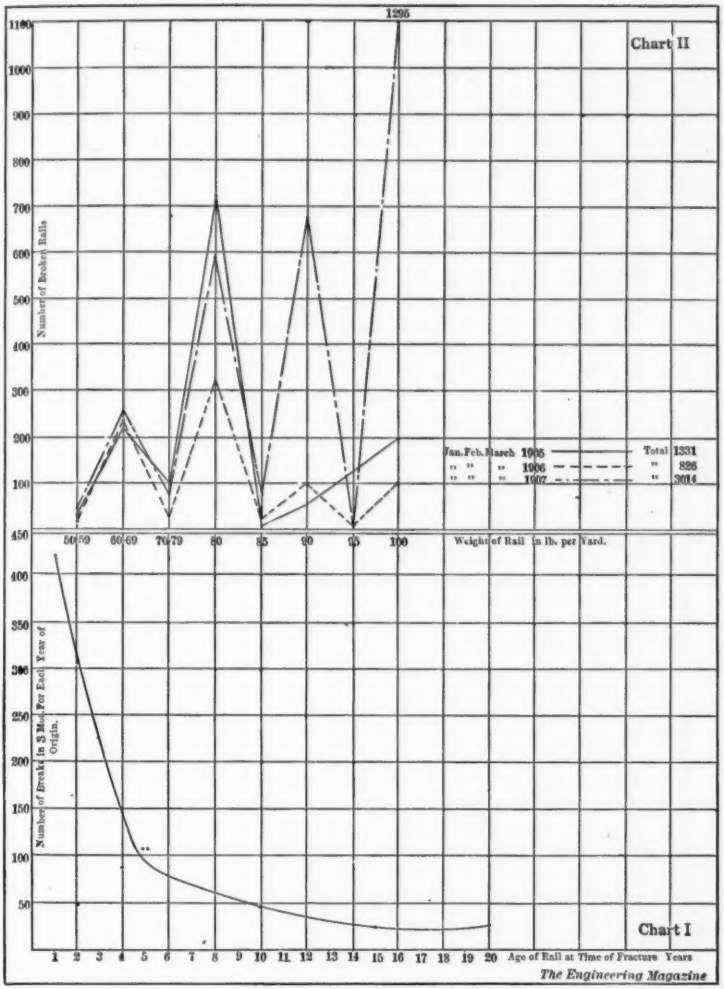
Chart IV gives the relations between the dates of manufacture and the total breakages for the periods of January, February, and March, 1905, 1906, and 1907.

Drawing 1 shows the general types of breakages that are liable to occur. This does not mean that these are the only kinds of breakages that ever occur, but that as a rule they may be classified according to one of these types.

Bearing these facts in mind we may now compare the arguments presented by the manufacturer and the consumer and see what force there is in them.

Rail Consumer.	Rail Manufacturer.
Bessemer Rails.	
The acid Bessemer process leaves in the steel practically the whole of the phosphorus which the ore contains, and it cannot be so altered under conditions of American manufacture at present as to remove the phosphorus.	Mr. W. R. Webster, chairman of the Committee on "A Standard Specification for Iron and Steel," for the Society for Testing Materials, says: "It must be admitted that the best rails are produced from steel low in phosphorus, rolled with light reductions and finished at proper low temperatures."
Dr. Dudley of the N. Y. C. & H. R. R. and Mr. J. W. Kendricks of the Santa Fe R. R. state that more time should be given to the process of manufacture.	Mr. P. E. Carhart, of the Illinois Steel Co., states that "the rail mills are using the same engines and the same speed that they did seventeen years ago, and that the time was saved in other ways, such as changing rolls, rather than in the passes."
The consumers or the railroads say that the Bessemer process is essentially a hit-or-miss process and that the phosphorus content and other injurious elements cannot be regulated with nearly the same degree of certainty as in the open-hearth process.	The rail manufacturer states that he is producing the best possible rails under the present conditions and at the present demand, and that to change over to the open-hearth process would involve the expenditure of millions of dollars, and that in the meantime he could not keep up with the demand.

Prof. H. M. Howe states that the acid Bessemer process can be improved: (1), by the liberal use of aluminum or its equivalent which will lessen segregation materially, but will lengthen the pipe, or where no pipe exists will increase the tendency to pipe. This tendency in turn will have to be met by cropping off and discarding a larger part of the top of the ingot; (2), by slow casting, which should shorten the pipe and raise the segregate toward the top of the ingot, in both ways less-


1295
Chart II
Number of Broken Rails
Jan. Feb. March 1905 — Total 1331
" " " 1906 - - - " 826
" " " 1907 - · - " 3014
50-59
60-69
70-79
80
85
90
95
100
Weight of Rail in lb. per Yard.
Number of Breaks in S.M. per Each Year of Origin.
Chart I
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Age of Rail at Time of Fracture Years
The Engineering Magazine

CHARTS I AND II.

ening the proportion of discard needed in order to get trustworthy steel; (3) by increasing the discard which should cut out the segregate and pipes. The richest of the segregate lies near the top of the ingot, usually in the upper 20 per cent, often in the upper 10 per cent of its length.

Rail Consumer.	Rail Manufacturer.
Section.	
Mr. C. S. Churchill of the Norfolk and Western R. R., states that an improvement in section is necessary, but does not believe it is necessary to enlarge the heads of rails. That recent experiments with rails have not proved that the present sizes of rails have not sufficient strength if properly made.	Prof. Howe says: "Another and expensive way of getting around the trouble would be to change the section in the direction of making the web and flange more nearly of the same thickness as the head." Mr. Webster states: "In a recent discussion it was claimed that the old committee of the American Society of Civil Engineers kept in mind the importance of low finishing temperature in designing their rails and gave sections best suited for that purpose. As a matter of fact, the heat treatment of steel was not properly understood at the time that committee made its report in 1892, and the sections do not permit of low finishing temperatures in rolling, owing to the width of the flange."
Axle Loads.	
Dr. P. H. Dudley says: "The axle loads have doubled in the past fifteen years, and the requirements for sound and safe rails exceed what some producers consider ample." Mr. H. B. Wille, of Baldwin Locomotive Works, states that the strength of rails has increased in greater proportion than the loads put upon them.	Mr. W. R. Webster: "In all justice it must be admitted that a fair percentage of breakages is caused by the great increase of wheel loads since 1892, the increase in speed of trains and use of large capacity cars." Mr. Carhart believes that a large proportion of the rail breakages are due to the impact of the blow from badly counterbalanced engines. Mr. Thackray, of the Cambria Steel Co., contends that the axle loads have increased much more rapidly than the strength of the rail section.

Specifications.

American Society for Testing Materials.

(a) Discard:—There shall be sheared from the end of the blooms formed from the top of the ingot not less than * per cent, and if from any cause the steel does not then appear to be solid, the shearing shall continue until it does.

(b) No bled ingots shall be used.

Chemical Properties.

Size of rail.....	50-59 lb. Per cent.	60-69 lb. Per cent.	70-79 lb. Per cent.	80-89 lb. Per cent.	90-100 lb. Per cent.
Carbon	0.35-0.45	0.38-0.40	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus	0.10	0.10	0.10	0.10	0.10
Silicon	0.20	0.20	0.20	0.20	0.20
Manganese	0.70-1.00	0.70-1.00	0.75-1.05	0.8 -1.10	0.8 -1.10

* Percentage not yet settled upon by the Society.

Drop Test.

Weight of Rail. Lb. per Yard.							Height of Drop in Feet.
More	than	45	to	and	including	55	15
"	"	55	"	"	"	65	16
"	"	65	"	"	"	75	17
"	"	75	"	"	"	85	18
"	"	85	"	"	"	100	19

The following is the result of nine tests of rails made by the Talbot continuous open-hearth process.

Carbon	0.477 per cent.
Silicon	0.372 " "
Sulphur	0.049 " "
Phosphorus	.0426 " "
Manganese	0.818 " "
Tensile strength	91,740 lb. per sq. in.
Elongation in 3 in.	13.9 per cent.
Reduction of area	14.4 " "
Deflection on drop test of 1 ton, 30 feet on 3 ft. 6 in. span.	3⅝ in.

Specifications for the Union and Southern Pacific Railways.

	75 lb. Per cent.	50 lb. Per cent.
Carbon	0.51-0.61	0.58-0.72
Phosphorus	0.06 max.	0.06 max.
Silicon	0.20 "	0.20 "
Manganese	0.75-100 "	0.80-1.03 "
Sulphur	0.06 "	0.06 "

British Standard Chemical Specifications for Steel Rails.

Carbon	0.35-0.50 per cent.	
Phosphorus	0.075 " "	maximum
Silicon	0.10 " "	"
Manganese	0.70-1.00 " "	
Sulphur	0.08 " "	"

The Pennsylvania Railroad have recently issued an order for 55,000 tons of rails under their new specifications, which allows the manufacturer considerable latitude as regards the percentage of crop end to be removed or discarded. These specifications drawn up for a new section state that the rail is to be free from all injurious mechanical defects. A history of the rail is to be kept during manufacture and in service. In order to test the rails to see if they come up to specification, the company has arranged for an elaborate series of tests. Bids are to be accepted on both open-hearth and Bessemer rails.

In 1905 nearly 12,500,000 tons of Bessemer and low-phosphorus pig were produced in the United States, compared with about 4,000,000 tons of basic pig. The total production of rails in 1905 amounted to 3,375,929 tons, of which all but 183,264 tons were by the Bessemer process. About sixty-three converters produced the supply of Bessemer rails during the year 1906. To produce the same tonnage by the

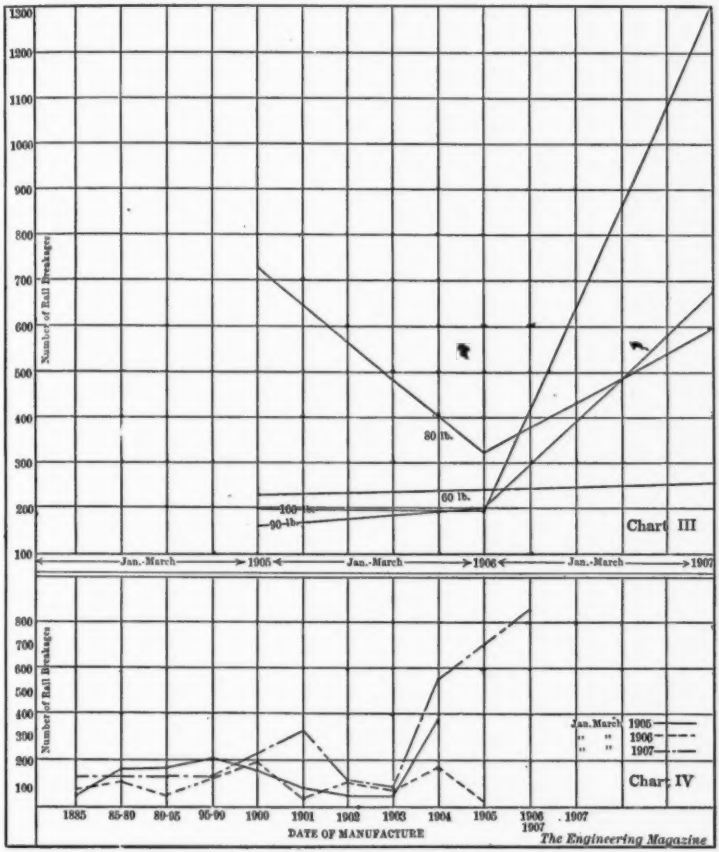
open-hearth process would require about 535 furnaces, costing approximately $20,000 apiece. Open-hearth rails are produced at present by the Tennessee Coal and Iron Company and by the Pueblo plant of the Colorado Fuel & Iron Co. In the immediate future open-hearth rails will be produced by the Bethlehem Steel Co., the Jones and Laughlin Co., and the Pennsylvania Steel Co. Hence it can be readily seen that when the steel maker says that the railroad man is unreasonable in asking him to change to the open-hearth process there is a good deal of truth in the statement.

A process which will undoubtedly help to solve the problem is the Talbot continuous open-hearth process. In this method, the molten pig iron from the blast furnace or an intermediate mixer, is added to a bath of metal and slag contained in a basic open-hearth furnace of about 200 tons capacity. The metal and slag are highly oxidized, and a violent reaction takes place, greatly reducing the metalloids of the added pig iron. The charge is then worked down in the usual way, and when of the desired composition, a fraction is poured off, which fraction is replaced at the proper time by a further addition of molten pig iron. The furnace has an output of about 150 tons in 24 hours.

Another process which has been successfully tried to some extent in

Road.	Length of Road Operated.	Length of Line in New York.	Car Miles.	Car Miles per Mile of Line (Approximately).	Life of Rail in Yrs.	Size of Rail in lb. per yd. Max.	Size of Rail in lb. per yd. Min.	1906. Number of Fractures.	1906. Fractures per Mile of Line.
Boston & Maine	2,241	146	117,500,000	52,500	12	100	56	7	.05
*Buffalo, Rochester & Pittsburg	568	203	43,340,000	76,500	6	100	60	4	.02
Delaware & Hudson	857	857	65,780,000	78,000	12	90	62	60	.07
Delaware, Lackawanna & Western	630	630	51,730,000	125,000	10	90	55	142	.11
Erie	1,884	1,301	212,300,000	112,000	10	90	56	22	.03
Lehigh Valley	1429	807	165,690,000	109,000	10	100	56	50	.06
N. Y. C. & H. R. R.	3,580	4,183	462,400,000	129,000	17†	100	56	288	.07
N. Y., N. H. & H.	2,062	160	139,300,000	67,500	12	100	56	2	.01
Western New York & Penna.	600	332	40,400,000	67,300	12	85	56	186	.56

* This is an ore road; has exceedingly heavy wheel loads.
† The rails were rolled under Dr. P. H. Dudley's specifications and supervision, which probably accounts for their long life.



CHARTS III AND IV.

the United States is the Duplex process. In this method, the pig iron is first de-siliconised; and, at least partially, decarbonised in an acid Bessemer converter. The partially blown metal is then poured into a basic open hearth furnace and the succeeding operations carried on there. Here the phosphorus and to some extent the sulphur are removed, and the carbon brought to the desired percentage. The combined costs of the operations are high, and the losses of iron in the slag are also excessive.

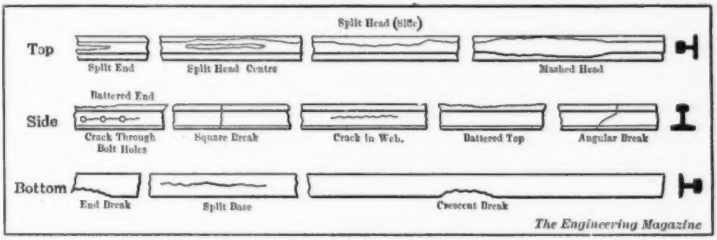
The two contentions, therefore, seem to be as to the phosphorus and the kind or shape of section. By what process or method the

phosphorus will be eliminated will be decided in the future, but there is no doubt that the phosphorus content must be decreased as the carbon increases, in order to prevent brittleness in the rails. That it can be eliminated in one process or another seems to be openly conceded and the choice hinges merely on expense.

As to the section question, the railroads must also be reasonable. From the standpoint of the metallurgist it is very difficult and almost impossible to roll the present section at the proper finishing temperature. To change the rail section so as to make the areas of the web and flange more nearly approach the area of the head would be expensive and would increase the weight of the rail to 115 or 120 pounds per yard, yet this would help the present situation immensely. The present section is designed on dynamic principles only. The web being so near the neutral axis does not, from a purely civil-engineering standpoint, need to be very thick. The flange is made broad so as to prevent the rail from cutting into the ties and from being over turned by lateral pressure from the flanges of the wheels, and therefore, does not need to be very thick. But the head is made thick in order to endure the concentrated wheel load applied to its upper surface, and to withstand the dynamic blows due to flat spots in tires or poor counterbalancing of reciprocating parts. Consequently the head cannot be made wide and thin like the flange; it must be relatively thick and narrow. These conditions compel the rolling to cease at a time when the metal in the head is too hot and is considerably above a proper finishing temperature. Almost every engineer knows that most of his troubles with steel can be directly traced to the heat treatment, and yet here the rail maker is compelled to roll a section to which it is manifestly impossible for him to give proper heat treatment. Furthermore, there is no reason except that of expense why the web and flange should be made thin. If they were made as above suggested, the cooling would not outrun the head, and the rolling would continue until not only the web and flange, but also the head, had cooled to a proper finishing temperature.

Hence the ideal rail is one which embodies all good points mentioned. The phosphorus content must be low, much lower than in the present Bessemer process, if this process is to hold its own. The phosphorus must decrease as the carbon increases so as to avoid brittleness. The section must be so designed as to take care of the dynamic and static stresses and also to allow the rail maker to roll it properly, working it to the proper crystalline structure and finishing at the proper temperature. The rolling should of course be so planned as to put sufficient work into the head, the part subjected to wear.

The question of high axle loads as argued by the rail manufacturer also deserves some consideration. The 20,000-pound freight cars formerly used have been replaced by those of 60,000, 80,000, 100,000, and even 200,000-pound capacity, the 60,000-pound being the light car of to-day, while the 100,000-pound is the standard for mineral traffic. The freight-train load has increased from 500 to 600 tons to 3,000 and 4,000 tons, and the volume of traffic in like ratio, as shown by the plates in THE ENGINEERING MAGAZINE for February. The axle loads under the freight locomotives have risen from 25,000 to 50,000 pounds, with four pairs coupled instead of two, and in the passenger service 55,000 to 57,000 pounds are common axle loads for some recent locomotives.



DRAWING I. DIAGRAMMATIC REPRESENTATION OF COMMON FORMS OF RAIL BREAKS. The crack through the bolt holes may extend through the head or web. The split base may extend at each end to the side of the flange.

In order to finish the investigation the problem of track design should be considered, and the loads and forces acting on the rails with the present system of rail support discussed. There is probably nothing in railroad construction so devoid of the principles of design as the track. There has been an evolution from the old strap rail up to those used at present. The rail has been designed and carefully tested, the tie spacing, the kind of tie, the method of holding the rail, and the bonding have all been carefully gone into; the road bed has been graded, filled, drained and ballasted, and yet there has been no co-ordination of all the component parts which make up the complete structure upon which the locomotive travels. The rail is subjected to bending moments, due to its acting as a continuous girder, amounting in some cases to 600,000 inch-pounds. The tendency of the rail to take the position of the elastic curve, also breaks out crescent-shaped pieces from the flange (see Drawing 1). Trolley roads design a rail of girder section so as to take care of these bending moments. Would it not be more rational simply to use the rail for its original purpose, and to design a homogeneous structure doing away with the cross-tie system, capable of acting as a continuous girder, with wide enough base or bases to take care of the ground reactions,

DAMAGE DUE TO DERAILMENTS.

Date.	Number.*	Kind of Train.	Killed.	Injured.	Damage to engines, cars and roadway.	Cause.
Oct.	4	Passenger	0	49	$7,700	Broken rail.—Speed 60 m. p. h. Rail had excess of manganese and phosphorus.
Nov.	..					
Dec.	..					
1906.						
Jan.	2	Passenger	2	15	.....	Broken rail.
Feb.	4	"	0	2	6,500	Broken rail. — One passenger car destroyed by fire.
March	8	"	1	5	11,260	Broken rail.
1907.						
July	1	Passenger	5	13	1,125	Failure of 100-lb. rail nine yrs. old. Cracked between ball and web.
Aug.	..					
Sept.	18	Passenger	0	..	63,000	Broken rail. — Train running 50 m. p. h. on straight line. Rail 12 yrs. old, bad interior defect.
1907.						

* Refers to numbers in Bulletins of Interstate Commerce Commission.

of sufficient depth to sustain the continuous-girder bending moments, and of such cross section as would allow for the elastic action produced by our present rail and cross tie system, with a proper method of fastening the rail to the girder, and with properly designed and connected tension bars to take up the tension produced by the lateral wheel pressure of the flanges? In other words our section would be an inverted "U" with wide bases. The direct wheel loads would make this section act like an arch, the thrust of one leg being taken up by the tension member, the other thrust being taken up simply by the friction of the base, and the ground gives us the elastic action that we desire. Such a homogeneous structure seems worthy of careful consideration. It would stop some of the dangerous rail breakages and give some relief from the perplexing problem of replenishing cross ties, and at the same time relieve the rail from some duties for which it was not originally designed and which it cannot therefore meet. The first cost of such a system per mile of line, would be higher than the present, but with the price of ties ranging from $0.60 to $0.90 apiece and continually soaring the cost per mile of line gradually decreases as a mean. The life of the outlined structure would be approximately that of the rail, and when the life of the tie is compared with that of this structure and the cost of replenishing it, the differential cost of the two systems per mile of line is considerably reduced.

EDITORIAL COMMENT

Engineering Ethics.

IN an address on the topic of "Engineering Honor" recently delivered before the Engineering Society of Columbia University, Dr. Schuyler S. Wheeler developed, and adapted to his special audience, certain ideas and recommendations for an established code of engineering ethics which had already found expression in his former argument of the same question in other circumstances. The distinguished past-president of the American Institute of Electrical Engineers recognizes clearly the objection that an effort to codify the ethics of the profession might have the effect, on some minds, of substituting the dry and necessarily partial letter of formulated law for the lively and complete spirit of engineering honor. He would keep constantly in mind the fact that the rules to be adopted could represent only the application of accepted principles to a certain number of cases, and that the principles themselves were greater than the rules and must be looked to for guidance where the rule was silent.

The perplexities, as Dr. Wheeler pointed out, appear chiefly in cases where duties to separate interests seem to conflict. A very interesting part of Dr. Wheeler's address was that in which he fixed the relative order of the three important duties of the engineer —"first, to his client; second, to the public; third, to his engineering society." The duty to the society was placed last, he explained, because it was a sort of extension of his duty to himself and therefore subordinate to his duty to others.

It has been charged against the old codes of other professions that they ranked the duty to the "society" or its equivalent above the duty to the client or the public. Few, probably, would dissent now from Dr. Wheeler's arrangement of the order. None could well object to the spirit defined for his code in language chosen from the preface written by Francis Bacon for his "Maxims of the Law:"—

"I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves to be a help and ornament thereunto."

The Prevention of Accidents.

THE fact has been often emphasized, especially of late, that the proportion of accidents to workers in manufacturing, mining, or transportation industries in Europe is but a fraction of that existing in this country, and that the intelligent and careful study given abroad to determining the causes of accidents, and preventive measures against them, appears to be largely creditable for the better situation there. Our workmen, even more than our manufacturers, might profit by study of the differing conditions and of remedies suited to our own case. Carelessness on the part of employees is no doubt a larger factor than indifference of employers in the American problem; and while the suffering falls first on the laborer, the financial burden of supporting the crippled, the incapacitated, the pauperized, falls inevitably at last largely on the manufacturer. We believe that at home, as abroad, it will be the manufacturers who will first and most effectively promote the campaign of education for safer conditions of industrial employment. We shall not long be left with only the one Safety Exposition—and that temporary, and the product of individual initiative and energy—to compare with the ten or more permanent museums of Europe.

As further evidence of the lead taken by the Continent in this direction comes the announcement of the "Eighth International Congress for the Prevention of Accidents" to be held in Rome this summer. The sessions of this body are held triennially, and draw together influential government officials, publicists, economists, and specialists. The reports are made by the most eminent technicians, and the published proceedings represent the record of the world's best advances in the prevention of accident. Membership in the congress is only $2.00, and intending subscribers may send the fee to Dr. W. H. Tolman, 231 West 39th Street, New York, by whom it will be acknowledged and forwarded to Rome. This subscription entitles the sender to all the reports and the complete proceedings.

Educating Industrial Engineers.

A LITTLE more than seven years ago, Mr. James Newton Gunn concluded an article in the Works Management Number of THE ENGINEERING MAGAZINE with these words:

"I believe so thoroughly in the fundamental importance of cost keeping and factory organization as to proffer this suggestion: that while engineering today has, as its recognized representatives, civil, mechanical, mining, and electrical engineers—those who deal rather with processes and mechanical methods—yet there exists a science which only awaits the creation of a literature to have its own existence recognized as a new department of engineering."

The prediction is now being realized. The steady upholding of this ideal by such leaders as Mr. Gunn; the growth and development of the literature—a very large proportion of it through the initiative or under the auspices of THE ENGINEERING MAGAZINE; and the constantly increasing and insistently evident demand for men with a new sort of specialized knowledge, expert in directing great manufacturing operations—these have at last proved to the world at large that a new professional field has opened for engineers, and that new means must be employed for preparing workers to enter it.

The most striking phenomenon of the coming era is the great awakening of the Universities to the call for a change in their long-established courses—a change which will bring the education of the student nearer to the conditions of professional employment as he must meet them after graduation.

The most notable movement is that at Columbia University, which will be adequately set forth by Professor Rautenstrauch in this magazine next month. The most important features in its peculiar effectiveness are, first, the thoroughness with which the elements of works management and of economical and efficient manufacturing are recognized and proportioned; second, the system by which the active participation of practical manufacturers, consulting engineers, and specialists is enlisted and co-ordinated, thus bringing the students into direct contact with master workers in the profession, and the newest thought and the latest practice in the field; third, the incorporation of this work as part of the essential preparation of all students in the department of mechanical engineering, instead of making it optional or special. It can no longer be said, as we said last September, that no scientific school makes "adequate provision for the student whose life work is to be superintendence of a manufacturing plant." The Columbia Schools of Applied Science now provide such training, and further give to every student in the mechanical engineering course those fundamental ideas of the elements of economy and efficiency in construction, operation, or production, which are vital to the success of engineering undertakings.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

IRRIGATION IN EGYPT UNDER BRITISH DIRECTION.

A REVIEW OF THE WORKS CARRIED OUT AND THEIR ECONOMIC EFFECTS.

Sir Hanbury Brown—Royal Society of Arts.

TWENTY-FIVE years ago last month the Irrigation Department of Egypt was placed under British direction by the appointment, as its head, of Sir Colin Scott-Moncrieff. In this comparatively short space of time, the nation has been brought from the verge of bankruptcy to a condition of such solid and rapidly increasing prosperity as to give assurance of the fulfilment of the prophecy made in 1898, that, "for its size, the province of Egypt would become the most valuable domain on the face of the globe." Lord Cromer, than whom no one is better qualified to judge, presiding at a meeting of the Royal Society of Arts on February 25, attributed this remarkable regeneration to the work of the Irrigation Department, which, more than all other influences combined, contributed to the financial rehabilitation of the country and laid the foundation for the vast moral and material improvement of recent years. A brief survey of the irrigation works carried out since 1883 and their economic effects is contained in the following abstract of a paper by Sir Hanbury Brown, read at the meeting referred to above. The paper dealt only with the results of the work of the Irrigation Department in Lower Egypt, without reference to the basin tracts of Upper Egypt or to the Sudan, where the problems of irrigation are only in the preliminary stages of study.

In the latter half of 1883 Sir Colin Scott-Moncrieff made a personal investigation of conditions throughout the country and when his staff of four engineers of the Indian Irrigation Service joined him the following year, they were assigned as Inspectors of Irrigation to separate sections of the country, with instructions to do what they could to put things right and to spend as little money as possible. The difficulties under which these Inspectors labored during the first few years were enormous. They were unable to obtain money for works of any magnitude and they had to contend against the open or hidden opposition of the native governors, who bitterly resented the interference of foreigners with their vested rights. The Inspectors, however, were able to accomplish a great deal, especially in the just distribution of water to rich and poor alike. Formerly the distribution of water had been under the control of the governors of provinces or the larger land owners, and the poorer cultivator was entirely at the mercy of his richer neighbor. The abuses which had grown up under this system were extremely difficult to eradicate but they were finally removed and a just and scientific system of distribution established.

The distribution systems, however, could not be established and maintained without the expenditure of considerable labor on the channels and banks of the canals. The funds at the disposal of the Irrigation Department were insufficient

to provide for the payment of the necessary labor and, much against their will, the Inspectors had to resort to the Corvée, or system of unpaid labor, which was of long standing in Egypt. Under the native governors this system had been one of extreme barbarity, involving the free use of the lash and subjecting both the impressed laborers and those dependent on them to the utmost rigor of cruelty and hardship. After the British occupation, the Corvée, so long as it existed, was reformed as far as possible and applied only to duly authorized works of public usefulness; but even under the most favorable circumstances it was but a poor and inefficient instrument. In 1884 the amount of unpaid labor used was equivalent to that of 165,000 men working for 100 days, but even this large army of laborers was insufficient for the amount of work which had to be done. The greater part of the labor was expended on clearing the channels of the deep canals of the cotton fields of Lower Egypt, which silted up badly during every flood and could not be cleared properly, under the Corvée, before water had to be admitted for the cultivation of the cotton crop. Relief had to be sought in some other direction.

"An attempt had been made to avoid the necessity of maintaining deep canals by raising the river water-level artificially at the head of the Delta. With this object a barrage, or river regulator, had been built across each of the Damietta and Rosetta branches of the Nile close below the point of bifurcation, some 15 miles north of Cairo. The work was designed to raise the natural water-level of the river at that point by 15 feet. Its construction was begun in 1843 by Mougel Bey, a Frenchman, and was supposed to have been complete in 1861. But the foundations had been so carelessly laid, and were so defective in consequence, that, when the work was subjected to a head of water in 1867, it showed such unmistakeable signs of failing that all attempts to use it for its original purpose were abandoned."

In 1883 the Barrage was declared incapable of raising the river levels in summer and valueless except as a bridge over the Nile, and a project was put forward to irrigate the whole of Lower Egypt by means of pumps. The arrival of Sir Colin Scott-Moncrieff and an examination of the Barrage by Sir William (then Mr.) Willcocks caused the abandonment of this project in favor of the restoration and strengthening of the original Barrage. This work was begun in 1885, a loan of a million pounds having been raised for the purpose. Each of the two regulators which together constitute the Delta Barrage consists of 61 openings of 5 metres width, fitted with a pair of iron gates sliding in vertical grooves, by which the water can be dammed to the height necessary for forcing the river discharge into the canals. Before the restoration work was begun, the regulating apparatus was entirely wanting on one section of the Barrage and on the other was incomplete and defective. Further, the foundation work was full of faults and before the regulating apparatus could be restored or repaired a new skin of masonry had to be laid over the old floor, with apron extensions up and down stream, and the foundations had to be consolidated by forcing cement grout into deep holes in the foundation material. The work of restoration was carried out with complete success and by June, 1890, the Barrage was made strong enough to hold up 13 feet head of water.

"Lastly, weirs have been constructed down-stream of the barrage on either branch, with the object of relieving the original structure of some of its work and, at the same time, of increasing its powers of control over the river, so that it has now been made possible to head up the river in summer to an artificial height af 20 feet, instead of 13 feet only. Consequently every drop of the summer Nile which reaches the head of the Delta is forced into the canals which carry it to the crops to be irrigated. Absolutely no water is allowed to flow past the Barrage along the natural channels of the river below it until such time as the rising flood has caused the canals to run with liberal discharges."

The great reduction in the labor of

clearing the Delta canals which resulted from the restoration of the Barrage made possible the abolition of the Corvée and the substitution for it of contract labor. "But the removal of this burden was not the only result of the full development of the working powers of the Barrage. In consequence of the better water supply obtained in summer by its action, the cotton crop, on which the wealth of Egypt depends, had been doubled, having increased from 3,000,000 to 6,000,000 cwt., or in value from £7,500,000 to £15,000,000. As the result also of the greater control obtained over the levels of the rising flood, the timely sowing of the peasants' food crop of maize had been ensured. Further, the cost of raising crops had been lowered in consequence of the reduction of the height to which the water had to be lifted for irrigation. Meantime the cultivated area of Egypt had increased from 5,000,000 to 6,000,000 acres, and the value of land had been doubled; while, at the same time that these benefits were accruing, the land tax had been reduced from £5,000,000 to £4,500,000.

"If these results are represented by figures giving their money value, it will be found that the return for the special expenditure of under £4,000,000, incurred in bringing these results about, was not a hundred per cent. only, but several hundred per cent."

Notwithstanding the enormous improvement made by the restoration of the Delta Barrage and the building of the subsidiary weirs, the continuous expansion of the cotton area soon reached a point when the total amount of water impounded by these large works was utilized in irrigation, and it was foreseen that, if the development of Egypt was not to be arrested, means must be found for supplementing the summer discharge of the river. Following the very low floods of 1899, conditions became acute in the summer of 1900, and it was only by the most strenuous efforts at conservation and the strictest regulation of distribution that the supply of the latter year was made to serve. The question of reservoirs for storing the surplus water of the flood and winter discharges of the Nile for use during the summer was placed in the hands of Sir William Willcocks for study and as a result of his investigations the construction of the Assuan dam was decided upon. It is estimated that the storage of water necessary for Egypt's fullest development amounts to 6,000 million cubic metres. The first project provided for the construction of a dam on the crest of the first cataract above Assuan, of a height sufficient to store 2,500 million cubic metres of water. Owing to the protests of archæologists against the submersion of the buildings on the Island of Philae, the height of the dam as first decided upon was reduced by 26 feet, and the capacity of the reservoir is, therefore, at present only 1,000 million cubic metres. The dam as it now exists is 1¼ miles long, has a maximum height of 127 feet and supports a head of water of 67 feet. Recently it was decided to raise the height of the dam by 5 metres and the high water level of the reservoir by 7 metres, so that in the near future the capacity of the reservoir will be increased to 2,300 million cubic metres.

"The further expansion of Egypt's prosperity which has followed as a consequence of the construction of the Assuan Dam, and the works subsidiary to it, has not yet reached its full development, and that is probably the reason why the annual official reports of the Irrigation Service have not as yet attempted a statement of results. However, here is one item mentioned in the report for 1906. 'The actual benefit which has, up to the end of 1906, resulted to the country (that is, Middle Egypt) from these works is estimated to be a rise of rental value of £E.1,770,000, and of sale value of £E.23,569,000.' There were then about 300,000 acres converted from basin to perennial irrigation out of a total of 400,000 acres to be eventually converted.

"Basin land is land that is inundated during the flood season and grows one crop of cereals or clover in a year. When it is converted from basin to perennially irrigated land—that is, when floods are excluded and irrigation is

provided all the year round—two crops a year are grown in place of one, and the rental and selling values of the land are more than doubled. The converted basin lands of Middle Egypt absorb the lion's share of the reservoir water; but the reservoir has also a high importance as providing insurance for the cotton crop of Egypt, valued at about £28,000,000. Land also in the Fayum Province has risen in value, and the area of cultivation there has extended in consequence of the improved conditions of water supply created by the construction of the Assuan reservoir."

The works mentioned above as subsidiary to the Assuam dam, themselves works of the first magnitude, include the Assiout and Zifta Barrages, the function of which is similar to that of the Delta Barrage. The former, consisting of 111 bays of 4 metres width, controls the distribution of water between Lower and Middle Egypt. The Zifta Barrage, on the Damietta branch of the Nile, distributes the waters of that branch to the canals on either side. Another barrage of 120 bays is now being constructed at Isna, about 100 miles below Assuan, to raise artificially the levels of low flood for the benefit of those basin lands of Kena which would otherwise not be reached by the inundation.

The binding of the Nile can never be made complete within the limits of Egypt proper. The future development of Egypt as well as the Sudan depends upon the solution of the problems presented by the Upper Nile, beyond the Southern boundary of Egypt. These problems are now being studied and it may be expected that eventually irrigation will work a transformation in the Sudan, similar to that which it has accomplished in Egypt under the British Protectorate.

THE CONSERVATION OF NATURAL RESOURCES.

A SYMPOSIUM ON THE CONSERVATION OF THE FORESTS, FUEL SUPPLIES, WATER POWERS AND WATERWAYS OF THE UNITED STATES.

American Society of Mechanical Engineers.

IN response to the invitation of the President of the United States to the engineering societies, to cooperate for securing the conservation of the natural resources of the country, the American Society of Mechanical Engineers devoted their April meeting to a consideration of this subject which just now is occupying so prominent a position in the public mind. The purpose of the meeting was announced as the discussion of the nature and extent of the resources of the country, the past and future demands upon them, the economy or wastefulness of methods of use, and the public policies best suited to their more efficient utilization and wise conservation. The four addresses delivered are published in abstract in the May *Proceedings*, from which the following summary has been prepared.

In introducing the subject of the conservation of waters and woods, Dr. W. J. McGee, Secretary of the Inland Waterways Commission, said that the future prosperity of the nation is bound up with this problem of the conservation of natural resources. What is most needed is an awakening of individuals to a sense of obligation for the preservation of the gifts of nature not only for the present, but for future, generations. Water is one of the most important resources to be conserved. The average rainfall over the mainland of the United States is about 30 inches, or 200,000,000,000,000 cubic feet, per year. As soon as the population and industries have increased to such an extent as to consume this annual rainfall, the limit of development will have been reached. About three-fifths of the rainfall is evaporated from the surface of the earth, another one-fifth passes deep down into the soil or is consumed in various chemical combinations on the surface, while the remaining one-fifth flows down to the sea. Too much of this last portion of the rainfall flows away on the surface and it is with its

conservation that the people of the United States should be most concerned. Owing to the deforestation of the mountains and foothills at the headwaters of streams, the soil no longer acts as a great sponge, drinking in the water and giving it out slowly, but it sheds the water with a rapidity which gathers it in torrents. The rapid variation in the levels of streams due to the very rapid run-off is having a great influence on navigation, but by far the most important and deplorable result of deforestation is the loss of the millions of tons of the best soil which are annually carried into the streams by the torrential surface waters, to the detriment at once of agriculture and navigation. This soil erosion amounts to between one and two billion tons annually.

The conservation of the fuel supply was discussed by Prof. W. F. M. Goss of the University of Illinois under the four heads of value, methods of production, wastefulness in utilization, and possible sources of economy. In 1850 there were mined in the United States 6,000,000 tons of coal. Since that date the production has more than doubled every ten years and in 1906 the production amounted to 414,000,000 tons. If we add to this amount of anthracite and bituminous coal the natural gas and oil drawn to the surface in the same year, the total fuel production reaches the enormous total of 440,000,000 tons. The methods of coal mining are very wasteful. Powder is used in many cases in which the coal should be cut by hand or by machine and excessive charges are common. In mining it is generally the practice to extract only the coal which can be easily mined and requires the least preparation for market. Thin layers, seamy coal, and coal high in sulphur are totally neglected and in most cases their value is destroyed by the methods employed in mining the high-grade coal. It is estimated that only about one-half the coal in the mines ever reaches the surface. In the case of oil the waste has not been so great, but the supplies of natural gas which should have lasted for generations have been exhausted in the space of twenty years.

In every movement of fuel from the point of production to the stack of the furnace there is waste which might be reduced or entirely eliminated by proper attention. The necessary steps to secure economy in the use of fuel are: scientific research for the establishment of facts; practical development of the facts thus established, on a scale which will convince men that there is a profit, direct or indirect, in a better practice; restrictive legislation which will protect the public from the competition of unscrupulous men; and effective inspection which will secure enforcement of laws. Economies can be secured at the mines by a more rational use of explosives, and washing and briquetting processes must be developed so that every ounce of available fuel may be utilized. The conservation of the fuel resources is an engineering problem and will yield only to engineering treatment.

In his address on the conservation of stream flow, water power and navigation, Prof. George F. Swain of the Massachusetts Institute of Technology said that streams may be preserved and regulated in two ways, by the preservation of forests and by constructing reservoirs. Many facts were cited to show the importance of forests as regulators of flow and examples were given of the effect of removing forests. It must be remembered that the value of a stream depends not on its total flow but on the regularity of that flow. Variations in streams greatly affect the economical utilization of water power which is one of the most important resources of the country. It is therefore of the greatest importance that the deforestation of the country should be arrested, both for the conservation of the timber supply and for the preservation of streams. The control of streams by storage reservoirs has not been undertaken to any great extent but it is a method which will naturally increase in importance. The reservoirs will be located near the headwaters of the streams, where the floods have their origin. Here also the effects of the destruction of the forests will be most injurious, owing to the erosion of the soil by the storm waters and melting

snows, and the consequent silting up of the reservoirs. The problem is one in which engineers should take an active and enthusiastic interest, for the formulation of a wise and broad public policy can be attained only by the assistance of the knowledge of the engineer.

This point was emphasized in the concluding address by Dr. Henry S. Pritchett, on the relation of the engineer to the body politic. A profession is distinguished from a business in that it is a vocation in which expert service is applied not only for the benefit of him who uses it but for the interests of the state and the public as well. The engineering works of antiquity were probably no larger than those of today but in many cases they were undertaken only for the personal glorification of some monarch and were of little moment for civilization or improvement. Today the engineer works always in the service of mankind and the engineering profession has entered into the company of those great callings whose members are recognized as not only the servants of those who employ them, but as the guardians, also, of the public interest and the public honor. The engineer is in a unique position to exercise by his advice, suggestion, and his consciousness of the public interest, a great influence in the encouragement of justice and wisdom. It will be a part of the honor due to his profession to look always at the larger than at the smaller view of development; to undertake the consideration of great enterprises rather from the standpoint of the great and unlimited future than from the standpoint of the small and limited present. In a word he will, if he be a true member of a profession, while serving loyally his employer, keep ever before the eye not only of himself, but of those whom he serves, the honor of his own profession, the debt which he owes to it, and the service of those larger interests of humanity which these considerations require.

THE NECESSITY FOR CORPORATION FORESTRY.

A DISCUSSION OF THE PROBLEMS OF FUTURE TIMBER SUPPLY IN THE EASTERN UNITED STATES.

E. A. Sterling—Engineers' Club of Philadelphia.

IN the present national movement for the conservation of the natural resources of the United States, the question of the timber supply is unquestionably of the most pressing and immediate importance. The forests of the country have been so depleted by wasteful methods of production and utilization of timber that their absolute exhaustion within a very few years can be prevented only by the practice of forestry on a large scale. The activity of the Forest Service of the Federal Government during the past few years has placed the immense forest lands of the public domain, lying for the most part west of the Mississippi, under a wise system of control, and, though a large part of the Western timber lands are still privately owned, the position of the Western States with regard to timber supply is more or less secure. In the East, however, no such conditions prevail. The timber lands are almost wholly in the hands of private owners and there is no guarantee of a rational conservation in the public interest, such as exists in the West, which will prevent the timber scarcity, already serious, from becoming more and more acute. In a paper read before the Engineers' Club of Philadelphia and printed in the January number of the *Proceedings*, Mr. E. A. Sterling, Forester for the Pennsylvania Railroad, asserts that the only possible solution of the problem for the large wood-using corporations of the East lies in the practice of private forestry on a large scale. His data and argument are most interesting and we present the main points of his paper in the following brief abstract.

"There are today many indications of timber scarcity which are all too evident to the business man, and it requires only a glance at statistics to show that con-

ditions will rapidly become worse unless prompt action is taken. The rise in lumber prices should in itself be sufficient to point out the need for economy and for the more conservative use of our forest resources, especially when we consider that certain grades of timber are hardly obtainable even now, at any price. Taking our more common kinds of lumber, we find that in the decade ending 1906 the wholesale price per thousand board feet for white pine, rough uppers, jumped from $52 a thousand to $92, while in the same period yellow poplar went from $32 to $53.50 per thousand, southern yellow pine from $14 to $29.50, and hemlock from $12 to $23 per thousand. Manipulation of the market may have accounted to some slight extent for this marked increase, but it is very certain that the main reason for the advance was the scarcity of the raw material. Taking white pine, for instance, which has long been one of our standard woods, we find that the total cut in 1905 was only 4,862,000,000 feet, and much of this was obtained by cutting over the original pine lands the second or even the third time. Since the maximum cut of some 8,000,000,000 feet of white pine back in the eighties there has been a steady falling off despite all efforts of the millmen to maintain higher outputs, The decline in white pine has thrown other woods into the lead, and in 1906 we find that yellow pine and Douglas fir, with 31.1 per cent. and 13.2 per cent., respectively, have increased rapidly in proportion to the total cut. In 1899, 22.5 per cent. of the lumber cut in the United States was white pine, in 1905 16 per cent., and in 1906 only 12.2 per cent., whereas Douglas fir in 1899 produced only 5 per cent. as against the 13.2 per cent. for 1906. Comparing the output of hard woods and soft woods, we find that in 1905, 81.3 per cent. of the total consisted of soft woods such as pine and spruce, whereas in 1899 the soft woods showed about 75 per cent. This change in ratio is due mainly to the increased cut of yellow pine and Douglas fir and the falling off in oak and yellow poplar."

The scarcity of certain kinds of timber is very seriously felt in a number of industries. The case of the vehicle manufacturers may be cited as a prominent instance. Hickory is used almost exclusively in the construction of the better grades of vehicles and as yet no satisfactory substitute has been found for it. Nevertheless, it is estimated that the present supply of hickory will last only twelve years, at the present rate of consumption of about 150,000,000 feet annually. To take another case, in railroad work the scarcity of suitable tie timber has become a serious problem. White oak has long been the standard timber for ties on the Eastern lines but the supply has fallen off to such an extent that many inferior species are now used at prices formerly paid for the best white oak. The average value of the 102,834,000 ties used in 1906 was 47 cents each but with the constant recession of the timber supplies from the lines of the railroads, the price is certain rapidly to increase.

Hickory and white oak are not the only hard woods of which the supply is waning rapidly. The production of all the more desirable classes of hard wood is decreasing notwithstanding the constantly increasing demand. During the period 1899 to 1906, in which the expansion of all branches of industry gave rise to an unparalleled demand for raw materials of all kinds, the decrease in the output of hard wood amounted to 15 per cent. and the corresponding increase in price varied from 25 to 65 per cent. The most desirable and widely used woods, oak, yellow poplar, elm, became increasingly more scarce and, to supply the deficiency in the better grades, resort was had to inferior woods, maple and red gum, the production of which continually increased. At the present time the consumption of hardwood timber of all grades, as lumber, ties, piling, poles, etc., amounts to over 25,000,000,000 feet annually, a consumption which the standing hard wood timber on even the highest estimate will be able to supply for only sixteen years.

Taking the whole timber supply of the country the prospect is not less discouraging. According to the most reliable statistics the annual consumption

of wood in all forms, in lumber, mine timbers, cooperage, packing boxes, pulp wood, fuel, etc., reaches a total of 100,000,000,000 feet, a per capita consumption of 440 feet as compared with Europe's 60. According to the most reliable estimates of the standing timber, an annual consumption of 100 billion feet will exhaust the available supplies in twenty years.

The problem of the future timber supply in the East will have to be solved mainly by the wood-using corporations. In the Western States, Federal and State control of the timber on the lands of the public domain will accomplish much but in the East a definite supply of timber at a reasonable price can be assured only by the individual action of the corporations. The lumberman, whom one would naturally expect to be most concerned about the future supply, can be depended on for but little assistance. He is concerned only with immediate profits and has no interest in ensuring the permanence of a timber supply such as the long-lived corporate concerns must have. The solution which the corporations, and particularly the railroads must adopt eventually will be the purchase of large timber tracts, their management on a long-time basis, and the preservative treatment of the timber so far as is consistent with the use to which it is to be put. Any other policy would be most short sighted. Mining companies which are paying in the neighborhood of one million dollars a month for mine timbers in the open market are endeavoring to increase the life of timbers by treatment with preservatives. The railroads are working along the same lines and are attempting to economize by getting the maximum life out of inferior timbers. But in view of the rapid exhaustion of the forests such expedients can be of but temporary relief. The only true economy, the only possible solution of the pressing problem of timber supply, lies in buying timber lands and placing them under competent forest management.

"Assuming that a large eastern corporation was in control of a timber reserve sufficient to fill its wood requirements wholly or in part, the next question would be how to operate to the best advantage. Naturally, the first step would be to place the property in charge of a forester who would make a plan of management in accordance with the local conditions of the tract and of his company's requirements. On typical forest land his first step would be the inauguration of a scheme of fire protection. This would be followed by such improvements in the line of mills, logging railroads, etc., as were necessary to the exploitation of the timber. With these facilities he could handle the orders placed by his company and deliver the material in any form desired. In cutting, his aim would be to utilize only the mature timber, provide as far as possible for natural reproduction by leaving seed trees and disposing of the slash, and, wherever it could be done with profit or without undue expense, thin out and improve his second-growth timber. He would at the same time replant open areas where there was no prospect for natural regeneration and, in short, would gradually bring every acre of the tract up to its maxamum production. The normal forest, with an annual cutting area and an annual budget equal to the increment of the whole stand, he could not expect to approach for many years, but conservative logging methods, fire protection, improvement cuttings, planting, etc., would gradually lead to this end. It is not unreasonable to anticipate that the day will come in this country when our economic conditions will permit the more intensive forest practice of our European neighbors. . . . .

"Although the idea that wood-using corporations should be wood producers as well is comparatively new in this country, several firms have already adopted policies of this kind. Of the Eastern railroads, the Pennsylvania and the Delaware and Hudson have appointed foresters and may be expected to work out their wood problems according to their own needs. In the West, the Santa Fe is the most active, and in addition to operating the largest and best creosoting plant in the country at Somerville, Texas, have purchased some

9,000 acres of land in southern California, where they will grow eucalyptus for ties. Since eucalyptus in that climate will grow into tie size in eight to ten years, and each tree produce two to three ties, an area of this size when planted will go a long way toward furnishing a continuous supply of tie timber. This same company has over 25,000,000 treated ties in track, and by this one process alone they will probably cut their annual consumption in half. The Southern Pacific, Union Pacific, Burlington, Rock Island, Illinois Central, and other of the large western roads are erecting or operating large wood-treating plants, and within a few years untreated ties will be the exception, west of the Mississippi at least. Of the coal and iron companies, the Lehigh Coal and Navigation Company is practising forestry on a large tract in the Pocono region of Pennsylvania; the Philadelphia and Reading Coal and Iron Company is treating mine timbers; the Lackawanna Railroad, with its affiliated coal interests, is taking up the question of timber protection and timber treating, while the Cleveland-Cliff Iron Company in Michigan owns very large areas of forest lands, which are under the management of trained foresters. Paper and pulp companies in New York and Maine have acquired large holdings of spruce and balsam and are practising primitive forestry, while the International Harvester Company owns and husbands its own supply of hard-wood.

"In conclusion, it can safely be said that most of our large corporations, as a matter of self-protection and economy, must sooner or later take up the practice of forestry. It will pay in most cases because eventually there will be no other solution, and the sooner the start is made the more profitable will be the outcome. From the broader patriotic standpoint of the nation and the State, the corporations and the lumbermen have it in their power to solve the great questions of stream flow, inland navigation, and water power, and to decide whether our lands which are unsuited for agriculture shall be barren wastes or productive of successive crops of timber for the nation's use. From the commercial and economical standpoint the attitude of these same industrial interests will largely determine whether the approaching timber famine shall be postponed indefinitely, or whether we shall soon be made to face a scarcity of one of our most useful products, which will paralyze many of our industries."

COMMERCIAL RESEARCH.

A DISCUSSION OF ITS FIELD AND METHODS OF INVESTIGATION.

C. E. Skinner—The Electric Journal.

THE following brief abstract of Mr. C. E. Skinner's address on the field and methods of commercial research, delivered before the Electric Club of Pittsburgh on January 27 and printed in *The Electric Journal* for April, can give but an inadequate idea of its interest. To Mr. Skinner, as head of the research department of the Westinghouse Electric and Manufacturing Company, are given opportunities to appreciate the importance of research work in manufacturing operations, not open to the engineer in other lines of work or even to the engineer connected with smaller manufacturing concerns. But no one in reading his address can fail to be struck by the breadth and variety of the problems connected with modern industry, for which the laboratory is required to furnish solutions, or to gain a clearer realization of the interdependence of, and the close connection between, science and industry. The bare outline given below can do no more than indicate the main points with which Mr. Skinner deals, without reference to the wealth of practical illustration to which his paper owes a large part of its interest.

Probably the most important branch of commercial research is that which deals with the investigation of the properties of materials. The variety of raw

materials used by a large manufacturing company is very great. In the case of the Westinghouse Electric and Manufacturing Company the number of classes exceeds five hundred, and the tests to which the materials must be subjected cover practically the whole range of physical and chemical science. In some cases the investigations follow well-established lines but frequently new tests must be devised to give the intimate knowledge of the properties of materials necessary for their economical purchase on specifications and for their efficient utilization. In many cases the research laboratory is required to develop new materials or new combinations of old materials to meet new and special conditions. Metallic filament lamps and alloy steels are striking examples of the manner in which the research laboratory responds to the demands of industry.

Closely allied to the determination of the properties of materials are the development and investigation of the processes by which they are treated to meet the conditions of manufacture and the methods of manufacture or of making combinations to fit the particular work in hand. This branch of commercial research is of large importance and the necessity for careful and thorough work is nowhere more apparent. For the development of a successful process the investigator needs to know very intimately the properties of the materials involved, the various methods by which they may be handled, and the results which must be obtained in the finished product. Investigations of this kind may develop into researches of the highest complexity and of far-reaching results.

All rational design is based on the disposition of material in such a manner as to take advantage of phenomena, usually related to the law of the conservation of energy. Among these phenomena the properties of materials are of great importance but design can by no means be limited alone to the consideration of the characteristics of materials. Hence an important branch of commercial research, and one which will probably never be exhausted, is the determination of the physical laws and the absolute values of those phenomena affecting design which lie outside the properties of materials. In all progressive work new phenomena of this kind and new phases of well known phenomena are constantly being observed and require investigation. It is impossible, of course, entirely to separate the phenomena which lie outside the properties of materials from those which depend on these properties. The investigation of the former class must recognize the results of investigation of the latter.

No less important than the design itself is the determination of its results. All design is more or less of a compromise. The phenomena which affect it are imperfectly understood and may be mutually opposed to one another. Hence the best designs are those which contain the most that is satisfactory and the least that is unsatisfactory. The examination of the results of design consists of making tests on the various features involved and determining whether or not the best compromise has been effected between the conflicting elements entering into it. Ordinary testing to determine whether a machine meets the specifications of a customer or designer is not to be considered research work but many cases arise in which totally unforeseen features or partial or total failure require careful and elaborate investigation. The investigation of the causes of failure of a machine is often of a most difficult and exacting character, for failure may arise from any one of a large number of causes, from faulty design, material, or workmanship, or from causes altogether outside ordinary experience and knowledge.

The development of new classes of apparatus, the critical study of existing designs, and the investigation of reputed inventions and discoveries of a doubtful nature are other important branches of commercial research. The first two require most careful and painstaking work, for the development of new, and the improvement of old, devices can be accomplished only by a systematic and broad-minded study of every possible factor.

The last usually requires nothing more than common sense and a firm grasp of fundamental physical laws.

As to the methods by which the various problems are to be attacked no general rule can be laid down. In some cases a solution may be reached by a cut and try method or by a process of trying everything possible. In the development of costly processes or large machines, however, the only commercially satisfactory method is that of advancing step by step from one definite, partial solution to another, and in general it may be said that this method is the best for any problem, even though it may take a longer time than others. Before attacking any problem, however, a process of elimination, based upon known facts regarding the properties of materials and the theoretical requirements of the results, should be carried out. It will usually be found that a careful preliminary consideration of all possible materials and processes, with the rejection of all obviously unsuited or doubtful, will reduce a problem to very simple proportions.

SERVICE PERFORMANCE OF THE LUSITANIA.

DATA ON THE STEAM AND COAL CONSUMPTION ON HER THIRD VOYAGE WEST.

Thomas Bell—Institution of Naval Architects.

THE paper from which the following extracts are taken was undoubtedly the most important and interesting presented at the recent meeting of the Institution of Naval Architects. Very full reports of the trials of the Lusitania have been published in the technical press but the subject was by no means exhausted and Mr. Bell's paper gave a great deal of detailed information in the form in which its importance can be appreciated most readily. With this part of the paper we shall not deal, since the main results of the trial trips were given in these columns in the October, 1907, number of THE ENGINEERING MAGAZINE. We present below, however, that part of the paper dealing with the results obtained under service conditions, which contains, we believe, the first authoritative statement of the performance of either of the great turbiners. The data given by Mr. Bell have reference to the Lusitania's third voyage west.

"With reference to the third voyage west, from November 2 to November 8 of last year, thanks to the courteous permission of the chairman of the Cunard Company, the leading particulars of the official engine-room log are summarised in the table below. Regarding the mean draught of the vessel at sea, it may be remarked that, after the second

ABSTRACT OF ENGINE-ROOM LOG FOR THIRD VOYAGE WEST: QUEENSTOWN TO NEW YORK.

Date when last Dry Docked, July 22, 1907. Mean Draught, leaving Queenstown, 33 feet 7 inches. Mean Draught, arriving New York, 30 feet 10 inches.

Date, 1907.	Steam Pressures. Boilers.	H. P. Receivers.	L. P. Receivers.	Temperatures. Hot-well.	Feed-Water.	Vacuum.	Barometer.	Length of Day.	Distance by Observation.	Mean Speed.	Mean Revolutions.	Mean Slip.	Coal Consumed for Main and Auxiliary Engines per Day.
	lb.	lb.	lb.	deg.	deg.	in.	in.	hr. min.	naut. m.	knots	per min.	p. c.	tons
Noon Nov. 3....	170	140.0	2.3	68	200	28	30.4	0 52	21	24.24	182.5	16.5	40
" " 4....	169.1	142.2	2.2	78	197	28	29.7	24 57	606	24.28	182.6	16.4	1090
" " 5....	167.3	140.6	2.3	78	198	28.2	30	25 2	616	24.6	182.8	15.4	1090
" " 6....	168.3	140.4	2.5	70	196	28.2	30.1	24 55	618	24.8	183.5	15.1	1090
" " 7....	168.3	138.3	2.2	72	195	28	29.6	24 52	610	24.52	181.4	15	1090
1.14 A. M., Nov. 8	165	132.5	1.5	75	200	27.8	29.3	14 2	310	22.09	174	20.2	576*
Total	....	....	..	...	...	...	...	114 40	2781				4976
Means	168	139.3	2.2	74.5	197	28.1	29.8	... ..	....	24.25	181.1	15.9	....

* This includes all coal used till 10 A. M. on the 8th.

Summary of total coal consumed on voyage:—Liverpool to Queenstown, 408 tons; Queenstown to New York, 4976 tons; galleys, etc., 18 tons: Total coal taken from bunker from leaving landing stage, Liverpool, till moored at wharf, New York, 5402 tons. Passage—Queenstown to Sandy Hook—4 days 18 hours 40 minutes.

day out, certain of the forward tanks were gradually filled for the purpose of avoiding excessive trim, so that the mean draught on November 5, 6 and 7 was approximately 32 feet, or very little more than the mean of the first pair of runs from Corsewall Point to the Longships and back. The conditions, however, were otherwise very different, for, with the exception of the twelve hours of fine weather and smooth sea from noon till shortly after midnight on November 6, it was, throughout, the average mid-Atlantic winter weather—namely, strong winds and resulting boisterous sea. Up till midnight on the 6th—*i. e.*, for 2176 nautical miles out of a total of 2781 nautical miles—the mean speed works out at 24.65 knots; but, unfortunately, early on the 7th the wind freshened, gradually increasing to a furious southwesterly gale, which reached its height about 4 P. M., and reduced the average speed for the last 24 hours below 23 knots, and thus brought down the mean average for the completed voyage to 24.25 knots. A table giving the mean average speeds at the different stages of the voyage, shows very clearly the effect of this gale, unfortunately so far as preventing the vessel from complying with the contract conditions, but giving those connected with the ship an opportunity of thoroughly satisfying themselves as to her behaviour when driving through huge waves at about 22½ knots, without any racing of engines or signs of labouring, and dispelling the idea current in some minds, that turbine-propelled ships do not show to advantage in heavy weather.

"The following particulars of the steam consumption are given in conjunction with the figures of coal consumption set forth in the table. Throughout the voyage a careful record of the feed-pump counters gave an average of 998,000 pounds of water pumped into the boilers per hour. Of this, about 114,000 pounds were used by auxiliary machinery exhausting into the feed-heaters, 26,000 pounds by the evaporating plant supplying feed make-up and washing water, and about 6500 pounds for steam to the thermo-tanks, galleys, and pantries, both of which latter figures are based on data obtained from tests carried out before the vessel left the Clyde. Hence, taking the average shaft horse-power as 65,000, the steam consumption per shaft horse-power-hour works out as follows:—

	lb.		Per Shaft Horse-Power Hour. lb.
Main turbines	851,500	=	13.1
Auxiliary machinery	114,000	=	1.75
Evaporating plant and heating	32,500	=	0.5
	998,000		15.35

Average amount of coal burnt per hour for all purposes	43½ tons
Water evaporated per pound of coal	10.9 lb. from and at 212 deg.
Water evaporated per pound of coal	10.2 lb. from a feed temperature of 196 deg.
Coal for all purposes per shaft horse-power per hour	1.5 lb.
Coal per square foot of grate per hour	24.1 "

Taking a mean displacement of 36,000 tons, this represents at 24½ knots per hour a consumption of almost exactly 11 pounds of coal per 100 nautical miles per ton of displacement. Half of the coal used was South Wales and half Yorkshire—practically the same as on the official trials."

THE QUESTION OF SPEED IN BATTLESHIPS.

A DISCUSSION OF THE RELATIVE VALUES OF SPEED, GUNS AND ARMOR.

Ensign R. R. Riggs—United States Naval Institute.

AS was pointed out very clearly in Mr. Sidney G. Koon's discussion of the size of battleships in THE ENGINEERING MAGAZINE for April, a satisfactory compromise between the conflicting military interests in battleship design can be arrived at much more easily in a large than in a small ship, and the general tendency in all navies is toward ships of larger and larger displacement. But though large ships are generally accepted as the

standard, there is no settled agreement as to the relative values of the military elements of speed, armor and armament in ships of a given displacement. It would seem, however, that naval architects are prone to exaggerate the importance of speed and to make excessive sacrifices of armor and guns to attain it. A vigorous and very interesting protest against this tendency is made by Ensign R. R. Riggs in a recent number of the *Proceedings of the United States Naval Institute,* from which the following extracts are taken.

"Speed is the most unreliable of these three elements: foul bottoms, poor coal, green firemen, accidents to boilers or steam line, minor accidents to engines, hot bearings, damage to stacks in battle, damage to hull by shells or torpedoes, or any one of a thousand things may neutralize a superiority in speed when the crucial time arrives. In some of the late British maneuvers, over half the battleships had to return to port on account of accidents to machinery, in a period of only two weeks, and this took no account of the hazards of battle. It may be argued that the slower fleet is just as liable to these accidents as the faster; true, but the slower fleet, if equally numerous and of the same displacements, must still retain its superiority in guns and armor, while if the faster fleet lose the advantage of speed, it is outclassed at all points and must be defeated. And this risk increases in proportion to the number of ships engaged, for there is just so much more chance of one ship being winged, and the speed of the fleet must be the speed of the slowest ship. This is one place where concentration of fire, aside from any technical considerations, is advantageous. If two ships are engaged with two others, and one pair concentrates its fire on one of the opposing ships, the total damage to each side in a given time will be equal, but the ship on which the fire of one side is concentrated will receive *all* the damage on her side and so will lose speed twice as rapidly as her opponents. Her faster consort must either slow to her speed, with no compensating gain, or else abandon her, and expose herself to a similar concentration. If ten ships are engaged on each side, this must take place five times as soon, and if they are of equal size, the slower will be consequently stronger in guns and armor, and so receive less damage than they inflict. Any damage to the battery and armor of the slower fleet is not open to the same objection, for it is local, and the damage to one gun or ship in no way effects the other guns or ships.

"It is frequently stated that the Russo-Japanese war illustrates the need of great speed for battleships, and this at the first glance appears to be true; but if the underlying principles are carefully studied, the fallacy of this is discovered. For example, at the battle of Tsushima, the Japanese fleet made about 15 knots to the Russians' 9 knots, and the Japanese won. But how much of the victory was due to speed, and how much to gun-fire? Had the fleets been equally well handled, and had the Japanese obtained their superiority in speed *at the expense of superiority in guns and armor,* would they still have won? That is the real point at issue. I think that no one will doubt that the result would have been the same had the Japanese not had the advantage of speed; it was this advantage *together with* superiority of gun-fire that made the victory so complete. As stated above, superiority in speed for a fleet in other respects equal to the enemy is of undoubted advantage, but should superiority in guns and armor be sacrificed for it? Another point shown by this battle. The Russian fleet was able to steam at 15 knots on leaving the Baltic, but it could make but 9 knots when the time arrived to use it, and Rozhestvensky's division of new 18-knot battleships could make but 11 knots on a spurt. Does not this illustrate the unreliability of speed when operating at long distances from a base? Do we find any similar deterioration in the battery or armor? These last were at least as good as when they left Russia. Furthermore, the Japanese armored cruisers were used in the line of battle, and had to reduce their speed to that of the battleships. Would not this extra weight given to speed which could not

be used have been better utilized in guns and armor? To be sure, Rozhestvensky attributed the Japanese victory to their superior speed, but he would be likely to assign any but the real cause to his defeat. If the crews could have been exchanged, which would have won. Japanese ships or Japanese personnel? Admiral Nebogatoff says that he surrendered because the superiority of the Japanese in speed enabled them to keep outside the range of his guns, and bombard him. Does not this show above all other things that the Russians were inferior in gun-fire as well as in speed? It should have been impossible for the Japanese to keep without the range of his guns and still do him any damage. . . . .

"If naval wars are, as history teaches, not to be decided by skirmishing or cross-raiding, but by one or more pitched battles, then every nerve should be strained, both in peace and war, to prepare for these *battles*. As armored cruisers have been shown not to be as valuable for this purpose as are battleships of the same size, they are a mistake. If this mistake has been made in the past then there is all the more reason for avoiding it in the future and this will not be done by repeating the error —the sacrifice of strength for great speed—in another form or under another name. I don't mean to say that very high speed is not valuable in its place, but putting it in large, imperfectly armed vessels is 'like putting all the eggs in one basket and putting the basket out to be kicked.' Contrary to strength, speed must be distributed through as many units as is practicable. . . . .

"There are positive disadvantages to high speed. Either the coal capacity of the ship must be increased, out of all proportion to the gain in speed, or else the radius of action must be correspondingly reduced. The disadvantage of the first is that on a given displacement the guns and armor must be reduced, and the disadvantage of the alternative is self-evident. Also, if it be such a problem to coal our fleet in time of peace, what would it be with greatly increased consumption and in war? The increased cost of maintenance might better be spent in other ways. When the armored cruiser squadron was out in the East it was the customary thing to see at least one of the ships coaling; so much so that they became known as 'Colliers' Weekly.' It was also a well known fact that, even with the coal bought at other ports, they were burning it faster than it was being sent out—and there were but four ships of moderate displacement—and in time of peace. . . . . .

"While guns and armor have been racing for supremacy, the highest speeds have remained nearly constant. The reason for this is that the horse power increases as the cube or even as the four power of the speed after a certain point is reached, and soon becomes prohibitive. The improvements in engineering have not changed this point to any great extent, and there is no immediate prospect that it will be changed. The calculations of a French officer, and one who is an advocate of high speed, show that to give an 18-knot battleship of 18,000 tons a speed of 21 knots, one-sixth of the battery or one-fifth of the armor must be sacrificed. This is a very large sacrifice, equivalent to five ships against six in offensive power, but for an increase of another three knots nearly twice as much of the remaining battery or armor would have to go. There may easily be a division of opinion as to the advisability of an increase from 18 to 21 knots, but I think that very few will think it advisable to sacrifice between 30 per cent and 40 per cent of power for an increase from 21 to 24 knots speed, and practically none will say that any decrease in speed below 18 knots would be compensated for (except in such cases as the *Idaho*, where the displacement was limited by law to an abnormal figure). Therefore the proper speed must be somewhere between 18 and 21 knots, and 19 knots may be taken as a good mean, above which the gain in speed would not justify the sacrifice in power, and below which the gain in power would be too small to justify a reduction in speed. The engines should be designed for a very high cruising speed, such as those in merchant vessels, for the real value of speed lies not in

the ability to make spurts, but in the wide field of strategy. Give the ships coal capacity enough to enable them to run from one base to another, with a good allowance for emergencies, and do this on the least displacement. In case improvements in machinery, such as turbines or internal-combustion engines, result in a saving of weight for a given horse-power, this weight may be better utilized in better protection than in speed."

RECENT DEVELOPMENTS IN THE GAS TURBINE.

THE CONTINUATION OF M. ARMENGAUD'S RESEARCHES AND THE APPLICATION OF THE GAS TURBINE TO SUBMARINE TORPEDOES.

Alfred Barbezat—Cassier's Magazine.

THE researches of M. René Armengaud on the gas turbine, culminating in the construction of a 300 horse-power unit, have probably constituted the most important individual contribution to its development. The experimental work on which M. Armengaud was engaged at the time of his death, in the summer of last year, has been continued by some of his former associates, and in *Cassier's Magazine* for April, M. Alfred Barbezat gives an interesting account of the more recent advances. Especially important in the extracts from this article, which are given below, are the data on the practical application of the gas turbine to submarine torpedoes.

"The early experiments were made with a small turbine of the De Laval type, capable of developing about 30 horse-power, and after studying the performances of this machine, when driven by compressed air alone, arrangements were made to test it in connection with a combustion chamber, delivering the products of the combustion of liquid hydrocarbon fuel at constant pressure through a nozzle upon the blades of the turbine. In these experiments the compressed air was furnished from an independent source, the object being to ascertain the action of the combustion in the chamber and the behaviour of the working parts under the conditions involved. The results obtained with this experimental machine were sufficiently encouraging to warrant the construction of the large 300 horse-power turbine.

"The general principle of this machine involves the delivery of air under pressure into a pear-shaped chamber lined with refractory material and provided with an expanding nozzle through which a uniform flow of gases can be delivered upon the blades of the wheel. In the center of the air nozzle there is arranged an axial tube, with a pulverizer at the inner end, through which the fuel in the form of gasoline, or similar liquid hydrocarbon, is forced into the chamber. The electric sparking device enables the fuel to be ignited on starting, after which the high temperature of the chamber maintains the combustion indefinitely. The high temperature produced by the combustion greatly increases the volume of the air, and this, together with the gaseous products of the combustion of the fuel, flows at a high velocity through the expanding nozzle upon the blades of the wheel.

"In dealing with such high temperatures, the temperature of the combustion being about 1,800 degrees C., the best refractory lining for the combustion chamber has been found to be carborundum, this being a product of the electric furnace, and thus having already sustained even higher temperature than those in the turbine combustion chamber. An elastic backing of asbestos provides for the expansion of the carborundum lining, and the nozzle through which the gases are discharged upon the wheel is also made of carborundum.

"In addition to the provision of a refractory lining, it has been found necessary to surround the combustion chamber with a water jacket in the form of a coil of pipe imbedded in the metal of the chamber walls, much in the same manner as such coils are used in the tuyeres of blast furnaces, and the cir-

culation of the water in the coil aids in keeping the temperature of the chamber walls within practicable limits.

"After the water has circulated in the jacket tube it is delivered, through small holes, into the gases just before they enter the nozzle, and is there converted into steam, this acting both to lower the temperature of the issuing gases to a point where they will not injure the blades of the turbine, and also itself being discharged upon the wheel with the gases and forming a part of the jet, which is thus composed of mingled gas, steam and highly heated air.

"In order to obtain the desired result of a machine involving only rotary motion, it is necessary that the compressed air by which the combustion chamber is fed should be produced, not by a reciprocating piston compressor, but by some form of rotary machine, preferably so arranged that it can be coupled directly to the turbine itself. This means that the rotary gas turbine must also include a rotary air compressor, and that such a compressor must have a high efficiency in itself, otherwise it will produce such a large proportion of negative work as to detract materially from the efficiency of the combined machine, even though the actual thermal efficiency of the turbine be high.

"After a number of experiments upon single-impeller turbine air compressors, driven at high rotative speeds by De Laval steam turbines, the services of Professor Rateau were enlisted in the work, and a multiple turbine compressor, designed by him especially for this work, was constructed at the works of Brown, Boveri & Co., at Baden, Switzerland. This machine is arranged in three sections and provided with continuous cooling circulation, and, being thoroughly tested, was found to be capable of delivering one cubic meter of air per second at a pressure of 6 to 7 atmospheres, with an efficiency ranging between 60 and 70 per cent.

"In this arrangement the compressor was found to absorb about one-half the total power developed by the turbine, the machine, when running at about 4,000 revolutions per minute, developing about 300 horse power over and above the negative work absorbed by the compressor. At the present time experiments are being made upon the thermal efficiency of the machine, which is, as yet, not as high as that of the reciprocating gas engine; but these tests are not yet completed, and the results not available for publication.

"During the past few months a practical application of this turbine has been made in connection with the operation of submarine torpedoes. It is well known that in certain types of such machines the motive power for the brief period which elapses between the discharge and the contact with the target is derived from a store of compressed air, and in some such torpedoes the compressed air acts upon a turbine wheel similar to the steam turbine. This principle has now been extended to the use of the gas turbine, the compressed air from the reservoir passing through a combustion chamber, and the total products of combustion, together with the vapour of water, acting on the turbine, largely increase its capacity.

"The turbines made for this purpose develop 120 horse power at a speed of 1,000 revolutions per minute, the expansion ratio being 8.4. The weight of the turbine alone is 73.16 kilogrammes, or about 1.3 pounds per horse power. Including the weight of the reservoir of compressed air, together with the petrol and water for a discharge lasting 80 seconds, the total weight of the whole apparatus is about 295 kilogrammes, or a little less than 2.5 kilogrammes, or 5.5 pounds, per horse power.

"Although the gas turbine is, therefore, still in the experimental stage, it has made material advances during the past year, the 300 horse-power combined compressor and turbine being an accomplished fact, and a number of 120 horse-power machines of a special type being actually installed in submarine torpedoes completed for active service. When this rate of progress is compared with the time required to bring the reciprocating gas engine to its present state of perfection, there appears to be reason for encouragement and interest."

TECHNICAL EDUCATION IN THE UNITED STATES.

A COMMENTARY ON VARIOUS FEATURES BY AN EMINENT BRITISH ENGINEER.

Sir William H. Preece—Royal Society of Arts.

TECHNICAL education in the United States is at a stage of more than ordinary interest. At least two important movements are clearly discernible — one toward standardization of requirements and courses, and the other (as yet localized and individualistic) toward bold and sweeping changes in curriculum and in modes of teaching applied science. While these tendencies are not necessarily opposed, at present they are pointing in opposite directions; one (probably unintended) is to give such force and authority to established, crystallized "standard" courses that change becomes more difficult; the other is to keep the entire scheme fluid and to run it into channels closely parallel to the engineering life of the day. This latter idea is apparent in Prof. Diemer's article, which we publish this month, and it will be presented again with clearness and vigor in Prof. Rautenstrauch's discussion following in our next issue.

The announcement of Sir William H. Preece's paper before the Royal Society of Arts therefore wakens expectancy of something peculiarly significant. The contact of a distinguished man with a great subject under auspices so high should yield a notable result. It is however a disturbing surprise to find that beyond his enthusiasm over the technical schools of the Carnegie Institute, the opening of which he attended, the eminent author has little to say that tends to enlightenment upon American technical education, and that much that he says tends in the contrary direction. Possibly the foundations he laid were too slight for an important structure to rest upon. He says:

"The old universities of America do not differ very widely from their ancestral type in the old country. The oldest of this class are Harvard, Yale, Princeton, Cornell, Johns Hopkins (Baltimore), and Columbia (New York), etc. I had on previous occasions visited Harvard and Johns Hopkins, and on my recent visit was prevented from going to Cornell. Cornell was founded by Ezra Cornell in 1807. Its centenary was celebrated last year."

Perhaps if Sir William had not been prevented from going to Cornell he would have learned that the centennial was of the birth of the founder, not of the University. Cornell was chartered in 1867; instead of being one of the oldest, it is one of the youngest of the American universities, while Johns Hopkins dates only from 1876. If the line of historic development be followed, with the great colleges might well be grouped the University of Pennsylvania, founded as a college in 1755 and recipient of the first university charter in America in 1779; or we might be told of some of the smaller colleges—William and Mary (1693); Brown (1764); Dartmouth (1769); Washington and Lee (1782); Williams (1793); Union (1795); the University of Virginia (1819). These, and others equally worthy to be noticed in their class, have all been intimately associated with the Colonial history of the country, or with the early days of the Republic, and with the education of men who have made American history.

Continuing his outline of the institutions to be considered, Sir William says:

"The best known State universities are those of Michigan, Minnesota and Illinois. The leading technical colleges are: Massachusetts Institute of Technology (Boston), the Stevens Institute (Hoboken), the Armour and Lewis Institutes, Chicago, the Pratt Institute, Brooklyn, and the Worcester Institute of Technology (sic). There is also a very fine trade school in New York."

The determination of the three "best known" State universities perhaps must be decided to some extent by one's own knowledge of the many institutions in this class meriting consideration. We

may admire without imitating the confidence shown in this definitive choice. But the list of the "leading technical colleges" (we say it without the least disrespect to the excellent institutions included in it) could scarcely be more curious. Are examples so pre-eminent as the Columbia Schools of Applied Science (formerly the School of Mines) or the Colleges of Engineering at Cornell University, omitted because the parent institutions have been mentioned before in another and a wholly different connection? Then what remains yet to be said of a selection catholic enough to range from the Massachusetts "Tech" to the New York Trade School, yet silent as to Rensselaer, the first college of civil engineering ever established and Alma Mater of some of America's best railroad men; ignorant of Purdue University, famous for its work in railroad technology; of Lehigh, unique in its instruction in coal mining; of Cincinnati, with its novel project for mechanical training; of Pennsylvania, ignored now in its technical as well as its classical schools; of Washington, Clarkson, Vanderbilt? But space fails for the mention of institutions which should be included if the scale suggested by Sir William's list is applied throughout; and yet no place has been made in his classification for examples so distinctive and interesting as the University of Chicago, or Leland Stanford Junior.

These exceptions are not taken in any spirit of captiousness, but pursuant to careful inquiry into the extent of the author's acquaintance with technical education in America, and therefore the validity of his deductions. There is no question as to Sir William's conscientiousness in recording the observations which he thinks he has made. He is almost painfully careful to explain that he is not certain whether it was at the Keighley or the Halifax Institute that Mr. Carnegie quoted his grandfather in 1900. He gives a pictorial typographic rendering of the Carnegie Institute yell. The difficulty probably is that the white lime-light which follows Andrew Carnegie wherever he goes is perhaps not the best for a clear vision or an accurate perspective of broad ranges. The tendency of this influence is shown by Sir William's enthusiastic statement in his first paragraph that by Mr. Carnegie's gifts "the enjoyment of literature, art, music and science has thus been placed within the free reach of every citizen in Pittsburg . . . . which has a municipal population of 750,000 people . . . . and is surrounded by a district of 2,000,000 souls." It appears two pages later that the entire plan contemplates tuition for but 4,000, that less than 1,400 are enrolled, and that the "reach" is not "free," but costs up to a maximum of $30 a year. It seems, in short, that the observations which Sir William was able to make during his trip, modified by former visits to Harvard and Johns Hopkins and by a disappointment in the direction of Cornell, are not many enough to admit of safe generalization. Take, for example, the paragraph toward the close of the paper in which a number of general propositions are advanced concerning educational conditions in the United States:

"A smart boy in America can get his education practically given free up to twenty-two years of age. There is everywhere co-education. There is no residential system at the universities. Accredited pupils can pass from the high schools to the university without an entrance examination. There is a close and almost organic connection between academic and industrial life. Culture is not neglected as with us. Teachers are actively engaged in the practice of their professions."

Scarcely one of these propositions is true of a mapority of cases, and many of them are true only of exceptional instances.

Again, Sir William has this to say of a certain class of material which he seems to think represents the student body of the American technical college:

"The American boy, the training of whose mind we are considering, possesses the energy and smartness of a new race. The European boy is mentally two years behind him. His precocity is assisted by his keenness and by his vivacity. He works with an object and a

determination to succeed. . . . This imbibed energy is not a question of race, but one of climate, for it affects all those who go there, whatever their nationality."

It is not difficult to believe that under the inspiration of Mr. Hammerschlag's unusual genius, many of these qualities were shown by the boys in the trade schools that Sir William visited. That they are not widely distributed is perhaps best proved by the comments of a New England Machinist in the April issue of THE ENGINEERING MAGAZINE, and those of a Southern shop superintendent printed elsewhere in this number. It is very doubtful indeed whether, among the classes making up the vast majority of students in American technical colleges, the American lad is at all ahead of the English lad of the same age. In fact, the English school system seems rather to cultivate a superior self-reliance which puts the English youth in the lead. But it would be interesting to know just what climate Sir William has in mind—Maine or California, Minnesota or Louisiana, Ohio or Colorado. The range of climate of the United States is as great as that between Sweden and Italy or between Switzerland and Japan. Are all these varieties so "champagne-like"?

Apart, however, from all these points of exception is the fundamental question as to what Sir William is talking about. He passes from manual training to technical education—from the New York Trade School to Johns Hopkins or Harvard—with such speed and suddenness that it is hard to disentangle the two ideas. He says that he has "always defined technical education to be that form of teaching which trains the brain to assist the hands." This scarcely seems to be an accurate description of the concept usually held in the United States. It is at once too broad and too narrow—too broad because it would cover equally well the training of a sculptor, a cigar-maker, or even a "professor of legerdemain"—too narrow because it omits most of the training of the technical man as exemplified, for instance, by the late Lord Kelvin, or Sir Benjamin Baker, or by Mr. John Hays Hammond. Except for some manipulative skill with instruments, usually needed only in junior positions, the technical man does not work with his hands.

The trade school and the college of engineering in the United States are wholly different in scope and purpose, working upon different material by different methods. The hopeless entanglement of the two ideas, and the attempt to make a composite picture with features from two radically different types, mingled at random, makes Sir William's image of technical education in the United States almost unrecognizable to those who know the original and quaintly misleading to those who do not. It is fashioned with evident enthusiasm and kindliness of purpose—but the likeness is not there.

THE STUDY OF ORE DEPOSITS.

A REVIEW OF PRESENT TENDENCIES AND THE PREVAILING THEORIES.

Waldemar Lindgren—Economic Geology.

THE advance in scientific knowledge during the nineteenth century is nowhere better illustrated than in that branch of the science of geology which is concerned with the study of the nature and formation of ore deposits. From insignificant beginnings, a series of notable achievements advanced it to a position of the utmost practical utility, based upon well fortified theories. As Mr. Waldemar Lindgren pointed out in his recent Presidential address before the Geological Society of Washington, the year 1900 may be taken as a year of equilibrium, in which the adherents of the various prevailing theories were somewhat evenly divided, but since that date the rapid development of the science has led to a number of changes in general opinion as to the manner of ore

deposition. It was the purpose of Mr. Lindgren's address to trace the general tendencies of thought during the first seven years of the present century, and a brief summary of his interesting review of present activities and theories is contained in the following abstract of his paper, as published in *Economic Geology* for December, 1907.

While the study of ore deposits was first put on a scientific basis in Germany, the variety and extent of the ore deposits of the United States and the generous aid given to their study by the federal and state Governments have placed the latter country at the head of the nations in extent of practical and theoretical investigations. In general activity, Germany undoubtedly occupies the second place, though here the advance is due mainly to individual effort unaided by state grants. Sweden and Norway are prominent, and in Austria-Hungary, France and Italy the work of investigation is being carried on by able and earnest students. In England, little attention is given to the subject but in many of the British colonies, notably Canada and Australia, a great deal of valuable and successful work is being done. In Latin America, Mexico has assumed the leading place but a great deal of activity is manifested in all the South American states. In the United States geological researches are, for the most part, published in monographic form, in which the results of thorough investigations in particular fields are recorded in great detail. Canada and Mexico have taken up monographic work on a considerable scale, and other countries to a greater or less extent, but a good part of recent literature, though valuable in many respects, is decidedly superficial in character.

A great part of the progress of recent years may be attributed to the universal appreciation of the necessity of microscopic study of rocks and ores. While microscopic investigations have been numerous, only one new method of importance has been developed, that of Campbell's application of metallographic methods to the study of opaque minerals. On the other hand, a field which has been too much neglected, as shown by the small amount of recent literature on the subject, is that of chemical geology. Early in his work the geologist is forced to recognize chemical work as absolutely essential but in most cases his own knowledge of analytical chemistry is insufficient and he has to resort to the services of a professional chemist in performing the experimental work necessary to support his deductions. Chemical geology has failed to advance as rapidly as it should because it is only rarely that chemists are interested in geology or have means or opportunity to pursue geological studies. As the most notable of recent contributions to this subject may be mentioned the work of Arrhenius and Vogt on differentiation in magmas, and of Kohler on absorption, but the vast number of questions which can be elucidated only by chemical research demands a large and systematic expansion of investigation in this field.

The general methods of the study of ore deposits may be classed as the monographic, as exemplified in United States practice, and the geographic. The latter neglects to a certain extent the minor features of deposits but studies a great number of adjacent localities in their geographic relations. To quote DeLaunay, who had been chiefly responsible for the development of the geographic method, it "desires to show the distribution of the various regional types of mineral deposits, and the accord of these types with the geological structure, with the age of the rocks and with the eruptive districts." The monographic method leads to a minute knowledge of a limited number of districts but without the application of the geographic method, knowledge of the distribution of metals and their connection with geological structure is insufficient. The study of hot springs, an important field in which but little advance has been made in recent years, is a case in which both these methods should be employed.

"Attempts have been made to perfect a genetic classification of ore deposits, but it must be confessed that we are still far from the goal, and many editors of text-books candidly throw consistent

genetic classification to the winds and describe ore deposits geographically, or by metals, or by the old terms of bedded, massive, or tabular deposits. Two genetic terms have, however, found general acceptance after their recent introduction by Stelzner and Beck. The terms are *syngenetic* and *epigenetic*. The former comprise those deposits which originate simultaneously with the surrounding rocks either through the differentiation of magmas, through mechanical deposition, or through chemical precipitation in seas or lakes. In the epigenetic deposits, on the other hand, the ores formed by filling or metasomatic action are later than the encasing rocks. During the last years many deposits have, by prevailing opinion, shifted their position in relation to these two distinctions."

In general the syngenetic class of igneous origin has grown considerably. Prominent examples of additions to it are the North Swedish apatitic iron ores and the Sudbury pyritic deposits, which are now regarded as products of magmatic differentiation on a large scale. On the other hand there is a strong tendency to transfer many occurrences formerly held to be of syngenetic-sedimentary origin to the epigenetic class. A great deal of discussion now centres about such deposits as the copper and lead-bearing sandstones, shales and conglomerates, the magnetite ores of Central Sweden, and pyritic occurrences. The prevailing theories, based upon recent investigations which disclose undoubted evidence of metasomatic action, tend to assign many of these deposits to the epigenetic class.

Contact metamorphic deposits have ceased to be considered oddities and exceptions and have taken their rightful place as a distinct and important class of occurrences. It is only within recent years that the study of metamorphic processes has been put on a thoroughly scientific basis but few advances have been more fruitful of results. Another subject of much importance has claimed attention recently, which may be called the counterpart in the study of ore deposits of historical geology in the larger field. This is the study of the various epochs of the formation of mineral deposits. To the geologist the processes of first deposition are perhaps the most interesting, but economically, to the mining industry, the study of secondary rearrangement and concentration has been attended by results of great importance and value. Another important feature of the study of ore deposits in which the mining industry is deeply concerned is the determination of form and structure, a field in which much progress has been made within the period under review.

"But after we are done with the description of our deposit and with the explanation, if attainable, of its manner of mineral formation, the question of its ultimate origin always remains, that most difficult and unsatisfactory chapter to write, since it is in part based on hypotheses and suppositions. Whence came these solutions, these carriers of the rarer metals? Aqueous deposition is universally accepted for the epigenetic deposition. We are all familiar with the theory of circulating and depositing or surface waters whose ablest exponent is Van Hise, and which found almost universal approval in the last years of the nineteenth century. The metals contained in the reascending surface waters were held by Stelzner to come from 'indefinite depths,' by Posepny to be extracted from the 'barysphere,' by Sandberger from the wall rocks of the deposits, by Van Hise finally by gradual solution of minute traces in the rocks during the descent of the waters. . . . .

"In the study of genesis, the most remarkable tendency during the last few years has consisted in the rapid and widespread, though not unanimous acceptance of the magmatic theory, according to which all igneous magmas contain water and dissolved metals which upon the ascent of the magma into a zone of lessening pressure are given off, penetrate the surrounding rocks, and ascend to the surface as thermal springs. The results would in consecutive order consist of: (1) Product of igneous differentiation in the magmas, (2) contact deposits at the point where the volatile substances left the magma, (3) deposits by magmatic wat-

ers on their way to the surface at greater or less distance from their point of origin and more or less mixed with surface waters. The theory that many hot ascending waters and much of their dissolved substances are of magmatic origin has been supported by some of the ablest men in geology. . . . .

"Perhaps the adherents of the magmatic theory go too far in some cases, as always happens in a new swing of opinion toward fresh and attractive views, but I believe it is safe to say that this theory has come to stay and that this and no other satisfactorily explains many ore deposits. Far be it from me to deny the power of surface waters, especially when somewhat heated by long underground passages, to dissolve and deposit material, and their work of concentrating metallic values is surely most efficacious in porous sedimentary rocks. Furthermore, it must be remembered that the magmatic waters constantly mix with those from the surface and that, as pointed out by many observers, this is one of the most potent causes for precipitation. . . . .

"The prevailing theoretical tendencies of the present day may be summed up as follows: We unanimously agree in seeking the ultimate source of the metals in the igneous rocks. We say that the rarer metals and other substances in aqueous solution emanate from the magmas during and after their irruption into higher levels of the lithosphere, and that minerals containing these metals are deposited along the pathway of the waters. We assert that heated atmospheric waters may search the congealed rocks, abstract from them a part of the small residues of the valuable metals and deposit them along their channels. We say further that metamorphism, aided by moisture, when acting upon these igneous rocks, is a potent factor in favor of further concentration.

"We say finally that as erosion degrades the volcanic mountains and their ore deposits, and the fragments are carried down to form sedimentary beds, the heavy native metals such as gold and platinum, are concentrated into placers, and the baser metals are distributed as salts of various kinds throughout the beds. Atmospheric waters take up these particles into solution, and, aided by the influence of sulphur compounds and organic matter, concentrate the deposits in congenial places. Ore deposits of value resulting from chemical precipitates in sea or lake water, form only in case of abundant metals like iron. It is possible that in this summing up is reflected too much of my own individual opinion, but I believe that it represents fairly the general trend of modern thought."

THE CONSTITUENTS OF STEEL.

A DEFINITIVE SUMMARY OF THE CONSTITUENTS RECOGNIZED IN METALLOGRAPHY.

Henry Le Chatelier—Revue de Métallurgie.

IN a paper published in the *Revue de Métallurgie* for March, M. Henry Le Chatelier attempts to give a simple and precise definition of the various constituents of steels. In introducing his subject he recognizes that perfect simplicity and precision of definition are unattainable, simplicity, because of the inherently complex nature of the problems involved, and precision, because of the incompleteness of metallographic knowledge. The slow progress of this study, notwithstanding the large number of researches already made, has been due to the experimental difficulties in dealing with minute particles of substances, which cannot easily be isolated from the complex mixtures in which they occur, but much unnecessary confusion has been introduced by certain investigators who have modified the application of the nomenclature originally adopted. It is possible, however, to outline the problems underlying the study of the constituents of steels, to give the facts already established, and to indicate the points still in doubt. The following abstract translation of M. Le Chatelier's article will indicate the unusually clear manner in which he reviews the present

state of the study of this branch of metallography.

Among the constituents of steel, at least four different species have to be distinguished: simple elementary substances; definite chemical combinations; solid solutions, also called compound crystals or isomorphous compounds, which are homogeneous mixtures, though in constantly varying proportions, of two or more different substances; and aggregates, heterogeneous matter formed by the mixture of homogeneous substances, elements, compounds or solid solutions. Regarding the latter, certain chemists have adopted the hypothesis that as aggregates become more and more fine in grain, they pass gradually into true solution and hence they introduce a special category of a state intermediary between the two extreme terms, which they designate under the name of emulsion or collodial solution.

The elementary substances found in steels are graphite, or pure carbon, and ferrite, or pure iron. Carbon exists in steel as an element only in the form of graphite, although different names are often employed to distinguish the free carbon of cast iron and steels, according to the conditions of its formation. Recent researches have shown, however, that the chemical properties of the carbon are always constant, the only difference lying in the size of the particles. Ferrite means primarily pure iron but the same name is retained for the solid solutions which iron forms with other elements, at least so long as the proportion of the latter is not too great. The ferrite of commercial steels always includes in solid solution in varying proportions some phosphorus, silicon, manganese, and doubtless other impurities. A combination of pure iron and pure carbon, Fe_3C, known as cementite, is the only definite chemical compound recognized in steels. The carbide of manganese, Mn_3C, can mix with cementite in solid solution but it is not known whether other elements can be introduced in this manner.

Before considering the nature of the different solid solutions occurring in steels, it is necessary to recall the allotrophic forms of iron, the existence of which was demonstrated by Osmond. There are at least two: alpha iron, normally stable at ordinary temperatures and characterized particularly by its magnetic properties; and gamma iron, stable only at temperatures above 900 degrees, and characterized by the absence of magnetic properties and by an electrical resistance at least ten times as great as that of alpha iron, measured at ordinary temperatures. The transformation of gamma iron into alpha iron is accompanied by a sudden change in linear dimensions, amounting to one or two thousandths, and by the production of considerable heat. A third form, beta iron, has been mentioned, stable between 750 and 900 degrees and differing from alpha iron only by the absence of magnetic properties but the effect of this form is not yet recognized.

The study of solid solutions in steel is rendered very difficult by the fact that none of them is stable at ordinary temperatures but at least two are recognized, austenite and martensite. Austenite is a solution in gamma iron of carbon, but whether in the form of pure carbon or of carbide of iron is not known. The solution, however, cannot contain more than 2 per cent. of carbon. It is stable between the point of solidification of the metal and a lower point of transformation, varying between 700 and 1200 degrees, according to the carbon content. Austenite can be preserved in steel at ordinary temperatures with great difficulty by very sudden cooling but it is never obtained pure. It is always mixed with martensite, troostite, cementite, etc. In the presence of sufficient quantities of nickel or manganese, in ferro-nickel with 25 per cent. nickel or in 13 per cent. manganese steel, it is stable at ordinary temperatures. Austenite is not magnetic and has a very high electrical resistance. Martensite also is a solution of carbon in iron. It is distinguished from austenite by the fact that it is very magnetic and it may be considered as a solution of carbon in alpha iron. It is the normal product when steels are quenched at or above 800 degrees. The sudden cooling hinders the

breaking down of the austenitic solution, but it does not succeed, except in exceptional cases in preventing the gamma iron from returning in that solution to the state of alpha iron.

In addition to these known solid solutions there is a certain constituent which M. Le Chatelier calls the constituent X, which may be a solid solution or a very fine-grained aggregate of indistinguishable elements. It is recognized by its property of taking an intense black coloration when the polished surface of a specimen of steel is etched by even the weakest acids. This constituent has been given various names, troostite, osmondite, troosto-sorbite, and even sorbite (Stead), the different names referring to the different conditions in which the constituent is obtained. Troostite is the name generally applied to the black substance obtained when steel with 1 per cent. carbon is quenched at the recalescence point, about 750 degrees. Osmondite is obtained by reheating an originally martensitic steel to 300 degrees. Troosto-sorbite is the name given to the black substance often observed in connection with martensite and austenite when steels containing over 1 per cent. carbon are quenched at temperatures above 1000 degrees. According to Stead's definition, sorbite is the black substance obtained by slow tempering of steel, as in the oil tempering process. Recent researches would seem to indicate that the constituent X is a very fine aggregate of ferrite and cementite, on account of the uniformity of some of its electrical properties with those of annealed steels.

In slowly cooled steels an extremely clean aggregate, pearlite, is formed, consisting of alternating particles of ferrite and cementite and with a structure corresponding to that of most eutectic mixtures. It is produced by the breaking down by slow cooling of the austenitic solution, which allows ferrite and cementite to crystallize out. Sorbite, according to Osmond, is a badly formed or granular pearlite, or one of structure so fine that its two constituent elements cannot be recognized under the microscope. It is normally produced by reheating martensitic steel above 300 degrees. The black matter becomes clearer and takes on an appearance more and more clean as the temperature of reheating approaches 700 degrees. When the point of recalescence is passed, normal pearlite is obtained on sufficiently slow cooling. There is no difference between pearlite and sorbite except a difference of structure. The elementary aggregates pearlite and sorbite may be found associated in the same specimen of steel with masses of ferrite and cementite or with some of the solid solutions, and aggregates of great complexity may result. Names have been adopted, after Howe, for three of these: euctectoid steel, exclusively of pearlite, with 0.8 to 0.9 per cent, carbon; hypo-euctectoid steel, an aggregate of ferrite and pearlite, with less than 0.8 per cent. carbon; and hyper-euctectoid steel, an aggregate of pearlite and cementite, with more than 0.9 per cent. carbon. Similar terms are employed for cast iron, the eutectic in this case containing about 4 per cent. carbon.

The most important points for elucidation are the nature of the constituent X; the rôle of beta iron in the solid solutions of certain steels; and the cause of the progressive increase in the electrical resistance of martensite with the temperature at which it is obtained. The nature of the constituent X is perhaps the most pressing problem and it is here also that the most trouble has been caused by certain investigators by the inexact application of certain terms. The constituent X has been called martensite, a distortion of the meaning of this term as applied by Osmond, its originator. The application of the term sorbite indifferently to imperfect pearlite and the constituent X is another source of confusion. Finally, almost every author has his own special signification for the new term hardenite, which is applied to martensite of a certain composition, to martensite in general, and to the constituent X. Since no usage has given a preponderating importance to any one of these significations, it would be as well if the use of the term were suppressed altogether.

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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The Semicircular Masonry Arch. A. E. Lindau. Extends the method of parabolic-arch analysis, proposed by E. E. Greene, to the analysis of the semicircular arch with fixed ends. 2500 w. Pro Am Soc of Civ Engrs—April, 1908. No. 9192I E.

See also Demolition, under BRIDGES.

Blackwell's Island.

The Channel Spans of the Blackwell's Island Bridge. Illustrated detailed description of these spans and the method of erection. 4000 w. Eng Rec—April 11, 1908. No. 91645.

Cantilever.

Cantilever Bridge Erection on the Guatemala Northern Railway. On a 60-mile section through a high mountainous country there are 57 single-track bridges. Describes erection methods. Ills. 1500 w. Eng Rec—Apr. 4, 1908. No. 91408.

See also Blackwell's Island, Quebec and Viaducts, under BRIDGES.

We supply copies of these articles. See page 495.

Columns.

A Summary of Tests of Large Columns: Appendix 13 to the Quebec Bridge Commission's Report. A study of large-size column tests. 2000 w. Eng News—April 9, 1908. No. 91605.

Safe Stresses in Steel Columns. Discussion of J. R. Worcester's paper on this subject. 9500 w. Pro Am Soc of Civ Engrs—March, 1908. Serial. 1st part. No. 91311 E.

Concrete.

See Piers, and Viaducts, under BRIDGES.

Demolition.

The Destruction of Arch Bridges, Etc. H. C. D. Scott. Deals principally with the methods adopted for destroying old arch bridges carrying public roads over a main line of railway. Ills. 3000 w. Soc of Engrs—April 6, 1908. No. 91774 N.

Drawbridges.

Swing-Bridge Over the River Avon, at Bristol. William Henry Bourchier Savile. Illustrated description of a bridge with a carriage road and a double line of railway. Plate. 6000 w. Inst of Civ Engrs, No. 3666—April 16, 1907. No. 91847 N.

The Pyrmont Bridge, Sidney, N. S. W. Percy Allan. Illustrated detailed description of the methods of construction used for this swing-bridge, and information relating to it. Plate. 7000 w. Inst of Civ Engrs, No. 3483—April 16, 1907. No. 91846 N.

Discussion and Correspondence. Combined discussion of papers by Percy Allan, and by William Henry Bourchier Savile on large swing-bridges. 16000 w. Inst of Civ Engrs—April 16, 1907. No. 91848 N.

A Drawbridge Wreck, and Temporary Construction to Restore Traffic. Mason R. Strong. Illustrates and describes this wreck at Cleveland, O., and the difficulties to overcome in restoring traffic; the methods adopted and time consumed are given. Ills. 2500 w. Eng News—April 2, 1908. No. 91333.

Failures.

The Failure of an Old Railway Bridge in France. Jean Phizey, in *Génie Civil.* An illustrated description of an accident occurring Aug. 8, 1907, at a bridge over the Loire near Angers. 1500 w. Eng News—April 9, 1908. No. 91602.

See also Drawbridges, under BRIDGES.

Floors.

Flooring vs. Stringers. Louis Ross. Discusses the problem of finding the distribution of loads, offering a solution. 3500 w. Eng News—April 23, 1908. No. 91878.

Manhattan.

The Towers on the Manhattan Bridge Over the East River at New York City. Illustrated account of the progress in the construction of the third suspension bridge between Manhattan and Long Island. 2000 w. Eng News—April 16, 1908. No. 91738.

The Erection of the Manhattan Bridge Towers. Illustrates and describes interesting details in the construction of the massive towers of this bridge across the East River, at New York. 3000 w. Eng Rec—April 4, 1908. No. 91402.

Masonry.

A Three-Hinged Arch Bridge of Freestone with Zinc-Filled Joints (Pont à Arcs de Pierre de Taille articulé à la Clef et aux Naissances avec Joints coulés en Zinc). Henri Tavernier. Illustrated description of this highway bridge of 25 metres span, near Lyons, France. 20000 w. Ann de Ponts et Chaussées—1907-V. No. 91508 E + F.

See also Arches, under BRIDGES.

Piers.

Substructure of Piscataquis Bridge, and Analysis of Concrete Work. G. A. Hersey, Jr. A general illustrated description of the construction of this railroad bridge, and also reports results attained with the different classes of concrete used. 1600 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91309 E.

Quebec.

Appendix 12, Report of Quebec Bridge Commission. A description of the fallen structure. Also Appendix 13, giving an examination of the various full-size column tests; and Appendix 14, giving a comparison of stresses. 9000 w. Eng Rec—April 11, 1908. No. 91652.

Appendix 15, Report of Royal Commission on Quebec Bridge. A description of researches made. Also Appendix 16, giving a discussion of the theories of built-up compression members, and editorial 14000 w. Eng Rec—April 18, 1908. No. 91783.

Appendix 17, Report of Royal Commission on Quebec Bridge Failure. Gives a comparison of certain chords with similar members of other large bridges. Appendix 18, gives a critical discussion of certain parts of the specifications. Appendix 19, on deflections under heavy winds. 6500 w. Eng Rec—April 25, 1908. No. 91934.

See Columns, under BRIDGES.

Reinforced Concrete.

Reinforced Concrete in Electric Railway Construction. N. M. Stark. Read before the Iowa St. & Int. Ry. Assn. On the value of concrete bridges, their design and erection. 1500 w. Elec Ry Rev—April 25, 1908. No. 91965.

Reinforced Concrete in the Construction of Highway Bridges and Culverts. James Mortland. Read before the Nebraska Ce-

ment Users' Assn. Considers briefly the materials in use for bridges and culverts, and discusses the adaptability of concrete for this purpose. 3000 w. Engng-Con—April 1, 1908. No. 91361.

A New Ferro-Concrete Bridge. Illustrated detailed description of a structure in Crewe Park. 2500 w. Engr, Lond—April 3, 1908. No. 91674 A.

The Henry Hudson Memorial Bridge. Illustrates and describes the reinforced-concrete arch bridge soon to be erected at New York. 1700 w. Sci Am—April 11, 1908. No. 91608.

The Reinforced-Concrete Bridge Across the Rhone at Pyrimont, France. An illustrated description, translated and abstracted from *Schweiz. Bau.* 1500 w. Eng News—April 2, 1908. No. 91329.

The Pyrimont Bridge (Note sur le Pont de Pyrimont). M. Schoendoerffer. Illustrated description of the design and construction of this bridge of concrete reinforced on the Hennebique system. 10000 w. Ann d Ponts et Chaussées—1907-V. No. 91509 E + F.

The Depression of Prince Regent Street in Wilmersdorf (Unterführung der Prinz-Regenten-Strasse in Wilmersdorf). Herr Hart. Illustrated description of a reinforced-concrete railway over-bridge. 2000 w. Beton u Eisen—March 12, 1908. No. 91575 F.

See also Trestles, under BRIDGES.

Steel.

Modern Simple Bridge Trusses of Long Span. C. R. Young. A discussion of spans over 300 feet, briefly considering the designs most used. 3500 w. Can Engr—April 3, 1908. No. 91376.

The Victoria Falls Bridge. George Andrew Hobson. Illustrated detailed description of the design and erection of this two-hinged spandrel-braced arch. Discussion and correspondence. Plates. 17000 w. Inst of Civ Engrs, No. 3675—March 19, 1907. No. 91852 N.

Strengthening a Double Line Railway Bridge. Aims to show how a girder may be designed to reduce just sufficiently the stresses in the existing girders. 2500 w. Engr, Lond—March 20, 1908. No. 91279 A.

Erecting the Springfield Bridge on Semi-Suspended Falsework. Illustrates and describes the methods used in replacing a bridge on the Boston & Albany R. R. across the Connecticut River. 1800 w. Eng Rec—April 4, 1908. No. 91385.

Erection of the Bellows Falls Arch Bridge. L. D. Rights. Illustrated detailed description of a highway bridge across the Connecticut River, an example of a through arch with a suspended floor. 3000 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91307 E.

Erection of French River Bridge—Canadian Pacific Railway. C. N. Monsarrat. Illustrated description of the erection of a long and heavy single-track span by the end launching method. 3000 w. Can Soc of Civ Engrs—April 16, 1908. No. 91895 N.

Changing the Steel Superstructure of the Bridge Over the Elbe on the Berlin-Magdeburg Line (Auswechslung der eisernen Ueberbauten der Bahnbrücke über die Elbe, Strecke Berlin-Magdeburg). W. Dietz. Illustrates and describes the methods used in replacing this bridge, span by span, the new trusses being completely built on shore and floated into position on pontoons after the old trusses had been removed bodily in a similar manner. 5000 w. Zeitschr d Ver Deutscher Ing—March 14, 1908. No. 91590 D.

See also Blackwell's Island, Cantilever, Columns, Drawbridges, Failures, Manhattan, Quebec, Transporter, Trestles, Viaducts, and Williamsburgh, under BRIDGES.

Suspension.

See Williamsburgh, under BRIDGES.

Terminals.

See same title, under STREET AND ELECTRIC RAILWAYS.

Transporter.

A New Transporter Bridge at Warrington. Illustrates and describes the methods of construction for this English bridge. 3000 w. Engr, Lond—March 27, 1908. Serial. 1st part. No. 91467 A.

Trestles.

Reinforced Concrete Trestle on the Burlington. Illustrates and describes method of renewing a timber trestle with a reinforced concrete structure. The work had to be put up under traffic. 500 w. R R Gaz—April 17, 1908. No. 91764.

A Large Wooden Trestle at McGill, Nevada. J. L. Dobbins. An illustrated detailed description of the timber and steel trestle approach to a smelter. 1200 w. Eng News—April 16, 1908. No. 91734.

Viaduct at the Steptoe Valley Smelting & Mining Company's Plant. Illustrated description of the wood and steel trestles forming a part of this plant in Nevada. 1200 w. Ry Age—April 10, 1908. No. 91689.

Viaducts.

Some Concrete Viaducts on the West Highland Railway. Walter Stuart Wilson. Brief illustrated description of two viaducts on this railway. 500 w. Inst of Civ Engrs, No. 3595—1907. No. 91856 N.

A German Railway Viaduct of Cantilever Construction with Novel Hinge Detail. Illustrated description of a structure at Westerburg, Germany. 700 w. Eng News—April 23, 1908. No. 91877.

We supply copies of these articles. See page 495.

Williamsburgh.

Additional Supports for the Stiffening Trusses of the Williamsburgh Bridge, New York City. In order to develop maximum carrying capacity, it was decided to strengthen the supports of the stiffening trusses of this large suspension bridge crossing the East River. An illustrated explanation of the work is given. 1200 w. Eng News—April 2, 1908. No. 91336.

CONSTRUCTION.

Barracks.

New Sanitary Detention Barracks at the U. S. Naval Training Station, Newport, R. I. R. E. Bakenhus. Describes barracks of interest on account of special features, and because of the great speed in planning and construction. 2500 w. Eng News—April 2, 1908. No. 91331.

Brickwork.

Reinforced Brickwork. Brief illustrated description of strengthening brickwork by binding it with wire mesh. 1200 w. Mech Engr—March 20, 1908. No. 91268 A.

Concrete.

See Foundations, under CONSTRUCTION; and Dams, and Sea Walls, under WATERWAYS AND HARBORS.

Concrete Blocks.

A Fireproof Garage. George E. Walsh. Illustrated description of a cement block structure. 2200 w. Sci Am Sup—April 11, 1908. No. 91609.

Earth Work.

See Dams, under WATER SUPPLY.

Factories.

Methods and Cost of Constructing a Brick and Steel Wire Glass Plant at Greensburg, Pa. A. E. Duckham. Details of cost and explanation of methods. 1800 w. Engng-Con—April 15, 1908. No. 91756.

The Fort Wayne Lamp Works of the Electric Company. A four-story reinforced-concrete factory building is described and the methods of construction used. Ills. 1800 w. Eng Rec—April 4, 1908. No. 91400.

Foundations.

Foundations. A. B. Clark. Describes some recent phases of development on the Manhattan Island, especially the use of high capacity piles of steel and concrete. Ills. Discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1908. No. 91629 D.

The Development of Building Foundations. Frank W. Skinner. An illustrated article describing the changes and difficulties in the preparing of foundations for the tall buildings now built in cities. 14000 w. Eng Rec—April 4, 1908. No. 91389.

Recent Developments in Pneumatic Foundations for Buildings. D. A. Usina. Reviews recent developments in foundations of the class used for high buildings in lower New York City. Ills. 3000 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91308 E.

Special Foundations for a New Edison Sub-Station. Describes piles of heavy steel tubes filled with concrete, and the methods used. Ills. 1200 w. Eng Rec—April 4, 1908. No. 91391.

A Stupendous Application of Concrete. Walter Mueller. Deals with its extensive use in the construction of the terminal buildings of the Hudson tunnels, more particularly in the foundations and approaches. Map and Ills. 2200 w. Cement Age—April, 1908. No. 91771.

Foundation Construction for the New Steel Capitol of South Dakota. Samuel H. Lea. Describes the character of the soil, the methods of determining the bearing capacity, and precautions taken to prevent unequal settlement. Ills. 2000 w. Eng Rec—April 4, 1908. No. 91395.

See also Piers, under WATERWAYS AND HARBORS.

Masonry.

See Dams, under WATER SUPPLY.

Piling.

See Foundations, under CONSTRUCTION.

Regulations.

Foreign Building Regulations. The present number considers the regulations in force in New York City. 2000 w. Builder—March 21, 1908. Serial. 1st part. No. 91257 A.

The Limitation of Height and Area of Buildings in New York. Ernest Flagg. Discusses the problem of limiting the height and area of buildings in the congested parts of cities, especially New York, giving suggestions believed to be effective. 2500 w. Am Archt—April 15, 1908. No. 91726.

The Regulations of the Austrian Department of the Interior, Relating to Construction in Rammed Concrete or Reinforced Concrete (Die Vorschriften des k. k. Ministeriums des Innern, betreffend die Bauweisen in Stampfbeton oder Betoneisen). 5000 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—March 6, 1908. No. 91581 D.

Reinforced Concrete.

Architectural Expression in a New Material. H. Toler Booraem. A discussion of practical and aesthetic problems of design in reinforced concrete. Ills. 7500 w. Archt Rec—April, 1908. No. 91303 C.

The Use of Reinforced Concrete in Engineering Structures. An informal discussion. Ills. 3300 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91312 E.

Graphical Determination of the Actual Stresses in Reinforced Concrete Beams

We supply copies of these articles. See page 495.

(Détermination graphique des Efforts réels dans les Poutres et Hourdis en Beton armé). J. Rieger. A mathematical discussion taking into account tensile stresses and the strength of concrete in tension. Ills. 5000 w. Génie Civil—March 7, 1908. No. 91528 D.

Reinforced-Concrete Cantilever Girders in the Boyertown Building, Philadelphia. A brief description of the main features of the design of this 10-story reinforced-concrete building, discussing details of interest. Ills. 1100 w. Eng News—April 23, 1908. No. 91879.

Reinforced-Concrete Building for Oil-Tank. C. F. Leonard. Read before the New England Assn. of Gas Engrs. Illustrates and describes a structure built to enclose an oil-tank in a thickly settled district, as a protection from fire. 4500 w. Pro Age—April 15, 1908. No. 91692.

A Ten-Story Building in Forty-seven Working Days. Describes the construction of a reinforced concrete building at 34 Fletcher St., New York City. Ills. 2000 w. Eng Rec—April 4, 1908. No. 91382.

The Construction of the Thirty-ninth Street Building, New York. An illustrated detailed description of the building of the McGraw Publishing Co. and its construction. 5000 w. Eng Rec—April 4, 1908. No. 91380.

The New Building of the Phelps Publishing Company. Brief illustrated description of a reinforced-concrete building for office and publishing business. 1800 w. Eng Rec—April 4, 1908. No. 91403.

Reinforced Concrete Power Station. Illustrated description of the construction of the Georgetown power station of the Seattle Electric Co., Seattle, Washington, which furnishes power for railways, lighting, etc. 2500 w. Cal Jour of Tech—Feb., 1908. No. 91302.

The Erection of the Westport Power House, Baltimore, Md. Illustrated description of the construction of a reinforced-concrete building. 1200 w. Eng Rec—April 25, 1908. No. 91932.

Extraordinary Public Works in Course of Construction in the Province of Ravenna, with Special Reference to Those of Reinforced Concrete (Lavori pubblici straordinari in Corso di Costruzione nella Provincia di Ravenna con speciale Riguardo a quelli in Cemento armato). Mederico Perilli. The works include sewers, locks, dams, bridges, breakwaters, etc. Ills. 7000 w. Ann d Soc d Ing e d Arch Ital—Feb.-Mar., 1908. No. 91532 F.

See also Factories, Foundations, Regulations, and Tunnels, under CONSTRUCTION; Reinforced Concrete, under BRIDGES; Sewers, under MUNICIPAL; Dams, and Purification, under WATER SUPPLY; Coast Protection, under WATERWAYS AND HARBORS; Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS; Poles, under ELECTRICAL ENGINEERING, TRANSMISSION; Dry Docks, under MARINE AND NAVAL ENGINEERING; Reinforced Concrete, under MINING AND METALLURGY, MINING; and Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steel Buildings.

Erecting Columns in Occupied Offices. Describes work on the old Singer building in raising it from 11 to 14 stories. 1200 w. Eng Rec—April 4, 1908. No. 91392.

The Erection of the Metropolitan Life Building Tower, New York. An illustrated article giving information concerning methods of erecting this 48-story structure. 3500 w. Eng Rec—April 4, 1908. No. 91396.

The Construction of the City Investment Building, New York. Illustrated detailed description of methods of erection used for this immense fireproof structure. 6000 w. Eng Rec—April 4, 1908. No. 91398.

The Construction of the Hudson Companies' Buildings, New York. Illustrated description of this important terminal and office building. 3000 w. Eng Rec—April 4, 1908. No. 91410.

Hippodrome Building at Cleveland, Ohio. James A. Joyce. Plans and description of difficult foundation work and details of a steel-frame building. 1700 w. Eng News—April 9, 1908. No. 91603.

Trusses.

Displacement Diagrams of Framed Structures by Deflection Angles. Myron S. Falk. Explains a graphical method which overcomes difficulties occurring when using the Williott diagram. 2200 w. Sch of Mines Qr—April, 1908. No. 91-913 D.

Tunnels.

The Second Raton Hill Tunnel of the Atchison, Topeka & Santa Fe Railway. Illustrated description of a tunnel under construction at Raton Pass, New Mexico. 2500 w. Eng Rec—April 4, 1908. No. 91404.

The East River Tunnels of the Pennsylvania Railroad. A general summary of the work, with illustrations. 2000 w. R R Gaz—April 3, 1908. No. 91435.

The Meeting of the Four East River Tunnels of the Pennsylvania Railroad. Particulars of this most difficult of subaqueous tunneling projects, with illustrations. 3000 w. Eng Rec—April 4, 1908. No. 91407.

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The Manhattan Cross-Town Tunnels of the Pennsylvania Railroad. Brief illustrated description of the main features of the engineering work. 1500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91717 C.

The "Subway," New York City. Sections 13 and 14. Stephen U. Hopkins. An illustrated description of the construction and methods on these sections. 4500 w. Harvard Engng Jour—April, 1908. No. 91837 D.

Tunnels Under the Chicago River for Electric Cables. George B. Springer. Describes the methods of construction and some of the interesting features. Ills. Discussion. 7000 w. Jour W Soc of Engrs—Feb., 1908. No. 91632 D.

The Construction of the Market Street Subway, Philadelphia, Pa. Illustrated description of the methods on the difficult City Hall section, and other sections of this reinforced-concrete subway. 3000 w. Eng Rec—April 25, 1908. No. 91929.

See also Sewers, uder MUNICIPAL; Tunneling and Tunnels, under MINING AND METALLURGY, MINING; and Subways, under STREET AND ELECTRIC RAILWAYS.

MATERIALS OF CONSTRUCTION.

Cement.

See Mortars, under MATERIALS OF CONSTRUCTION.

Masonry.

The Effect of Temperature Changes on Masonry. Charles S. Gowen. Gives a report of observations of various cracks occurring in the masonry sections of the new Croton Dam. 3000 w. Pro Am Soc of Civ Engrs—April, 1908. No. 91920 E.

Mortars.

Portland Cement Mortars and Their Constituent Materials. Richard L. Humphrey and William Jordan, Jr. Reports results of tests made at the structural-materials testing laboratories, Forest Park, St. Louis, Mo., 1905-1907. Ills. 30000 w. U S Geol Survey—Bul. 331. No. 91705 N.

Steel.

The Work of the Testing Department of the Watertown Arsenal, in Its Relation to the Metallurgy of Steel. James E. Howard. Remarks on the tests of steel ingot metal and derivative shapes. 2200 w. Bul Am Inst of Min Engrs—March, 1908. No. 91709 C.

Timber.

A Graphical Comparison of Various Log Rules. Arthur H. Morse. A comparison of rules for ascertaining the number of board feet of 1-inch lumber which can be sawn from a log of given diameter and length. 1800 w. Eng News—April 9, 1908. No. 91604.

Structural Timber. W. K. Hatt. Discusses the physical character of wood fabrics, indicating the effect on its strength of various elements arising during the growth of the tree, and some of the operations necessary in preparing the material for market. Discussion. Ills. 8500 w. Pro W Ry Club—March 17, 1908. No. 91835 C.

Timber Preservation.

The Analysis and Grading of Creosotes. Arthur L. Dean and Ernest Bateman. Gives experimental data and conclusions. 7000 w. U S Dept of Agri, Circ 112—Feb. 26, 1908. No. 91959 N.

Kansas City Plant of the American Creosoting Company. Illustrated detailed description of a plant designed for treating ties by the Lowry patented process. 2500 w. Ry Age—April 3, 1908. No. 91412.

MEASUREMENT.

Surveying.

Survey of Inaccessible Places by Tacheometry. Otway Fortescue Luke Wheeler Cuffe. A description of instruments used and work done, to obtain data for the construction of a lighthouse on a rocky coast. Ills. 2000 w. Inst. of Civ Engrs, No. 3644—1907. No. 91854 N.

Results of Base Line Measurements through the Simplon Tunnel, March 18 to 23, 1906 (Die Ergebnisse des Basismessung durch den Simplontunnel vom 18 bis 23 März, 1906). M. Rosenmund. Describes the methods of measurement and gives the results. Ills. 2000 w. Schweiz Bau—March 14, 1908. No. 91551 D.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

MUNICIPAL.

Garbage Disposal.

City Wastes Disposal and Street Cleaning. Paul Hansen. Abstract of a paper before the Ohio Engng. Soc. A study being made by the State Board of Health concerning the disposal of city refuse. 1500 w. Eng News—April 23, 1908. No. 91880.

Report on Street Cleaning and Waste Disposal, New York City. Extracts and general review of a report recently made by a committee appointed by the Mayor. Also editorial. 7500 w. Eng News—April 23, 1908. No. 91881.

Parks.

The Construction of Small Parks in Chicago. Linn White. An illustrated article on the construction and maintenance of these parks and the problems connected with them. Discussion. 7000 w. Jour W Soc of Engrs—Feb., 1908. No. 91634 D.

Pavements.

Street Paving in London. A summary of the report of the Metropolitan Paving Committee. 2800 w. Surveyor—April 17, 1908. Serial. 1st part. No. 91963 A.

The Cost of Brick Pavements and Cement-Mortar Curbs at Centerville, Iowa. M. G. Hall. Records of labor, material, and cost accounts. 1000 w. Eng News—April 2, 1908. No. 91334.

Detailed Cost of Jobs of Laying Asphalt Pavement in a Southern California City. Gives details of costs for two pieces of work. 2500 w. Engng-Con—April 1, 1908. No. 91362.

Comparative Strength of Brick and Concrete Foundations for Brick Pavements. Extracts from a report of Prof. I. O. Baker, concerning results of tests made, showing that a brick foundation is more than equal to a concrete. 1500 w. Munic Engng—April, 1908. No. 91474 C.

Public Baths.

The Municipal Public Baths at St. Gallen (Das städtische Volksbad in St. Gallen). A. Pfeiffer. A description of the building and the mechanical equipment. Ills. 3000 w. Serial. 1st part. Schweiz Bau—March 7, 1908. No. 91550 D.

Roads.

Progress Reports of Experiments with Dust Preventives. Experiments made by the Office of Public Roads during 1907. 9500 w. U. S Dept of Agri, Circ. 89—April 20, 1908. No. 91958 N1

Sanitation.

The Sanitary Campaign in California. An account of work to prevent the reappearance of the bubonic plague. 4000 w. Eng Rec—April 11, 1908. No. 91651.

Sewage Disposal.

See Purification, under WATER SUPPLY.

Sewers.

The New Main Intercepting Sewer at Waterbury, Conn. William Gravin Taylor. Illustrated description of the construction of this reinforced-concrete sewer. 1500 w. Eng Rec—April 4, 1908. No. 91406.

A Large Double-Barrel Sewer Built Across a Salt Marsh. Describes work on a reinforced-concrete sewer in progress in the borough of the Bronx, New York City. 3000 w. Ills. Eng Rec—April 4, 1908. No. 91388.

A Private Sewer Tunnel in Rock Excavation. Illustrates and describes the private sewer that serves the depressed yard of the N. Y. C. & H. R. R. R. Co. 3000 w. Eng Rec—April 11, 1908. No. 91650.

Some Construction Methods on Metropolitan Works. Howard S. Knowlton. Describes methods adopted in the handling of the field work in the construction of the sewerage system in the Boston Metropolitan District. Ills. 2000 w. Eng Rec—April 4, 1908. No. 91399.

The Canal Street Tunnel Sewer, New York City. Illustrated description of the rearrangements of the sewer system in the district traversed by the new subway loop to connect the Manhattan terminals of the Brooklyn and Williamsburgh bridges with the present subway lines. 2800 w. Eng Rec—April 18, 1908. No. 91780.

Stone Crushing.

A Commercial Stone-Crushing Plant at North LeRoy, N. Y. John Rice. Description of this plant. 2000 w. Eng Rec—April 4, 1908. No. 91284.

Street Cleaning.

See Garbage Disposal, under MUNICIPAL.

WATER SUPPLY.

Aqueducts.

See Ashokan, under WATER SUPPLY.

Ashokan.

Subsurface Investigations on the Catskill Aqueduct, Board of Water Supply. Robert Ridgway. A general description of this great engineering structure, with special description of the methods of exploration necessary to locate the aqueduct. Ills. 4500 w. Eng Rec—April 18, 1908. Serial. 1st part. No. 91779.

Explorations for Hudson River Crossing of the Catskill Aqueduct, New York City. Alfred D. Flinn. Explains the character of the problem as given by expert geologists, and describes the results of borings made, especially the sub-aqueous drilling. Ills. 4000 w. Eng News—April 2, 1908. No. 91332.

California.

Rain and Run-Off Near San Francisco, California. C. E. Grunsky. An analysis of rainfall and run-off conditions. 5500 w. Pro Am Soc of Civ Engrs—April, 1908. No. 91922 E.

Dams.

The Design of Buttressed Dams of Reinforced Concrete. R. C. Beardsley. Explains the calculations necessary in designing a dam of this type. 2000 w. Eng News—April 23, 1908. No. 91882.

Masonry Dam Formulas. Orrin L. Brodie. Presents a series of formulæ deduced by the writer in connection with studies made for the Board of Water Supply of the City of New York. Ills. 7000 w. Sch of Mines Qr—April, 1908. No. 91912 D.

A Few Words About Hollow Concrete-Steel Dams. Charles H. Eglee. Describes the construction, for reservoir purposes, of a dam of the open-front storage type.

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Ills. Discussion. 5000 w. Jour N Eng W-Wks Assn—March, 1908. No. 91720 F.

Cost of Earth Work on the Belle Fourche Dam, South Dakota. Describes this construction work in S. Dakota, giving tables of costs. 1000 w. Eng News—April 2, 1908. No. 91330.

An Earth Dam with a Reinforced Concrete Core Wall at Dixville, N. H. Arthur W. Dudley. Describes the construction. 1200 w. Eng Rec—April 25, 1908. No. 91931.

The Marseilles Concrete Dam. Dr. J. H. Goodell. Illustrated description of difficult engineering work in Illinois. 1600 w. Sci Am Sup—April 18, 1908. No. 91748.

A Combination Dam and Bridge. Brief illustrated description of a reinforced-concrete structure at Horse Shoe, N. Y. 400 w. Eng News—April 9, 1908. No. 91600.

The Cataract-Dam. Illustrated detailed description of the construction of a rubber masonry dam for water conservation in New South Wales. 1800 w. Sci Am Sup—April 4, 1908. No. 91375.

A Drained Cement Revetment with Galleries, on the Upstream Side of the Masonry Dam of the Mouche Reservoir (Revêtement drainé en Mortier de Ciment avec Galeries visitables sur le Paremont amont du Barrage en Maçonnerie du Réservoir de la Mouche). A description of large works carried out to protect the masonry of the dam. Plate. 18500 w. Ann d Ponts de Chaussées—1907-V. No. 91511 E + F.

See also Masonry, under MATERIALS OF CONSTRUCTION; and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Fire Protection.

See Fire Boats, under MARINE AND NAVAL ENGINEERING.

Irrigation.

Irrigation in Egypt. Brief illustrated descriptions of plants for the works at Fadlab and Atbara. 1000 w. Engr, Lond—April 17, 1908. No. 91983 A.

Home-Making by the Government. C. J. Blanchard. An illustrated account of the eleven immense irrigating projects to be opened in 1908. 9500 w. Nat Geog Mag—April, 1908. No. 91902 C.

A Large Irrigation and Power Project in Southern California. Illustrated description of an extensive project under construction in San Bernardino Mountains. 4000 w. Eng Rec—April 4, 1908. No. 91386.

Pipe Corrosion.

The Action of Water on Pipes. Freeland Howe, Jr. Treats of the causes, extent, and results of water action, and the remedies. 4500 w. Jour N Eng W-Wks Assn—March, 1908. No. 91721 F.

Pipe Laying.

Laying a 20-Inch Water Main Under Sidewalks. Describes work recently carried out at Utica, N. Y. 1200 w. Eng Rec—April 4, 1908. No. 91387.

Pueblo, Col.

A Notable Ground-Water Development at Pueblo, Colo. Explains the conditions and the development made 14 miles north of Pueblo, in the underground flow in the valley of the Fountain River. Ills. 5500 w. Eng Rec—April 4, 1908. No. 91383.

Purification.

Purification of Water Supply at Lawrence, Mass. J. Rodney Ball. Reviews the history of filtration in this city since 1893, showing the increase in healthfulness. Ills. 2200 w. Munic Engng—April, 1908. No. 91475 C.

Construction Methods at the Water Purification Plant at Toledo, Ohio. H. McKechnie. Illustrates and describes the construction of the reinforced-concrete mechanical filtration plant. 2500 w. Eng Rec—April 4, 1908. No. 91394.

Water and Sewage Purification Legislation in Ohio. A bill turning the control of stream pollution, sewage and water purification over to the State Board of Health. Also editorial. 2800 w. Eng Rec—April 11, 1908. No. 91646.

Reservoirs.

Some Construction Methods at the Croton Falls Reservoir. Illustrates and describes methods and appliances. 3500 w. Eng Rec—April 11, 1908. No. 91648.

Small Communities.

The Collection and Storage of Water for Domestic Purposes in Connection with Farmhouses and Villages. Harold G. Turner. Prize essay. The sources of supply, their palatability and wholesomeness, are considered. 3000 w. Plumb & Dec—April, 1908. Serial. 1st part. No. 91655 A.

Softening.

Water Softening at Oberlin, Ohio. W. B. Gerrish. Reports the success of softening with lime and soda ash. 1200 w. Eng Rec—April 18, 1908. No. 91782.

Tanks.

The Use of Steel in the Construction of Large Water Service-Tanks. Charles Walter Smith. Describes tanks used by the Board of Water Supply, Sydney, N. S. W. Ills. 2500 w. Inst of Civ Engrs, No. 3677—1907. No. 91843 N.

Water Works.

The Indian Creek Water Supply System of the Pennsylvania Railroad. J. W. Ledoux. Describes an elaborate system

to supply the lines between Philadelphia and Pittsburg. Map. 3000 w. Eng News —April 9, 1908. No. 91606.

WATERWAYS AND HARBORS.

Barge Canal.

Progress on Section 11, New York State Barge Canal. Recent work between Pendleton and Tonawanda is illustrated and described. 1500 w. Eng Rec—April 4, 1908. No. 91397.

Construction Work on the Erie Barge Canal. James Cooke Mills. An illustrated article explaining the magnitude of this work and describing methods of excavating, the machinery used, etc. 2200 w. Cassier's Mag—April, 1908. No. 91454 B.

Canal Haulage.

Notes on Electric Haulage of Canal Boats. Lewis B. Stillwell and H. St. Clair Putnam. Appendix to paper (No. 90832) on tests on the Lehigh Canal. 600 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91704 D.

Canals.

Mountain Canals, a New, Natural System of Water Transport (Gebirgskanäle, neues, natürliches Wasserstrassen-Transportsystem). An illustrated description and discussion of the Caminada system. 3300 w. Serial. 1st part. Oest Wochenschr f d Oeff Baudienst—March 7, 1908. No. 91584 D.

See also Barge Canal, and Panama Canal, under WATERWAYS AND HARBORS.

Coast Protection.

Method of Constructing Reinforced-Concrete Slope Paving for Holland Dikes. H. Huisman. (Condensed.) Illustrates and describes the DeMuralt system. 1400 w. Engng-Con—April 8, 1908. No. 91613.

Groynes of Reinforced Concrete to Check Coast Erosion. J. B. Van Brussel. Illustrates and describes this system of protection to be used at Brighton, England. 800 w. Sci Am Sup—April 25, 1908. No. 91892.

Colorado River.

The Lower Colorado River During and After the Freshet Stage of 1907. C. E. Grunsky. Describes the results of returning the river to its old channel, after the flood of the Salton Basin. 1500 w. Eng News—April 16, 1908. No. 91735.

Diving.

See same title, under MINING AND METALLURGY, MINING.

Dredging.

Dredging Equipment on the Panama Canal. F. B. Maltby. A brief description of the dredging machinery in use. 4000 w. Pro Engrs' Club of Phila—Jan., 1908. No. 91630 D.

Removal of Subaqueous Rock at Blyth. Georg Duncan McGlashan. An account of the use of a Lobnitz Patent Rock-breaker, stating its advantages. Ills. 4000 w. Inst of Civ Engrs, No. 3723—1907. No. 91845 N.

Floods.

The Flood of March, 1907, in the Sacramento and San Joaquin River Basins, California. Discussion of paper by W. B. Clapp, E. C. Murphy, and W. F. Martin. 7500 w. Pro Am Soc of Civ Engrs —April, 1908. No. 91923 E.

Great Lakes.

The Right-of-Way of the Great Lakes. F. C. Shenehon. Discusses the right-of way of the transportation system on the Great Lakes, and the importance of maintaining the lake levels. 6000 w. Jour Assn of Engng Socs—March, 1908. No. 91724 C.

Panama Canal.

The Panama Canal and the Middle West. Robert Isham Randolph. Argument for the improvement of inland waterways, especially the Mississippi and its branches, that the products of the middle west may find a shorter route to the Panama Canal. Map and Ills. 4000 w. Marine Rev—April 9, 1908. No. 91639.

Piers.

Concrete-Cylinder Sinking at Haulbowline. Harry Ekermans Oakley. Brief illustrated description of foundation work for a berthing jetty at Cork. 1500 w. Inst of Civ Engrs, No. 3707—1907. No. 91853 N.

Pollution.

New York Laws Relating to the Pollution of Streams. A. H. Seymour. From the Report of the seventh annual conference of Sanitary Officers of New York, giving information concerning these laws. 2000 w. Munic Engng—April, 1908. No. 91473 C.

Sanitary Investigation of the Mohawk River Drainage Area. Information from the Bulletin of the New York State Board of Health, concerning the river pollution, with recommendations. 700 w. Eng News—April 2, 1908. No. 91335.

River Regulation.

River Regulation, with Special Reference to the Ontario Peninsula and to the Grand River. W. H. Breithaupt. Read at Engrs' Club, Toronto. Map, and outline of possible development. 2000 w. Can Engr—April 10, 1908. No. 91681.

The Regulation of Streams with Shifting Beds, such as the Loire (De la Correction des Rivières à Fond mobile telles que la Loire). M. Audouin. A description of conditions and the works carried out to improve navigation on the Loire. Ills. 4200 w. Bul Soc d'Encour—March, 1908. No. 91526 G.

We supply copies of these articles. See page 495.

Sea Walls.

The Concrete Sea-Wall at Cebu, Philippine Islands. H. F. Cameron. Illustrated description of this sea-wall and the methods of construction. 2500 w. Eng Rec—April 25, 1908. No. 91928.

U. S. Waterways.

Our Inland Waterways. W. J. McGee. Reviews the history of waterway development in the United States and the recent work of the Inland Waterways Commission. 7000 w. Pop Sci M—April, 1908. No. 91300 C.

The Further Improvement of Our Inland Waterways. Major C. S. Riché. Read before the Contemporary Club of Davenport, Iowa. General suggestions for waterway connections, urging their need and advantages. 3500 w. Eng Rec—April 25, 1908. No. 91930.

See also Panama Canal, under WATERWAYS AND HARBORS.

Water Powers.

The Great Water Powers of the Provençal Alps (Etude des grandes Forces hydrauliques de la Région des Alpes Provençales). René Tavernier. A general report, and a report of the special investigations carried out in 1904-5. 18000 w. Ann d Ponts et Chaussées—1907-V. No. 91510 E + F.

MISCELLANY.

Forestry.

The Practical Work of the United States Bureau of Forestry. Day Allen Willey. Brief account of the work. 1800 w. Sci Am—April 25, 1908. No. 91890.

What Forestry Has Done. Treadwell Cleveland, Jr. Gives facts showing what forestry has done in other countries. 10000 w. U S Dept of Agri, Circ 140—Jan. 28, 1908. No. 91957 N.

Grubbing.

Methods of Grubbing Stumps and Trees with Machines. Illustrated description. 900 w. Engng-Con—April 8, 1908. No. 91614.

Natural Resources.

Conservation of the Natural Resources of the United States: the Work of the U. S. Geological Survey. Herbert M. Wilson. A summary of recent work by the U. S. Geol. Survey. 7000 w. Eng News—April 9, 1908. No. 91601.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Wireless Telegraph and Telephone. Thomas E. Clark. A general explanation of the method of sending wireless messages, and the special advantages of the Clark system. 5000 w. Jour Assn of Engng Socs—March, 1908. No. 91722 C.

A Study of the Propagation and Interception of Energy in Wireless Telegraphy. C. A. Culver. Deals with the relative efficiency of several different types of receiving systems. 2500 w. Elect'n, Lond—April 10, 1908. Serial. 1st part. No. 91815 A.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Submarine Telegraphy.

Submarine Telegraphy. Charles Bright. Gives a general idea of the theory and practice of transmitting electric signals, and experiences connected with the development of submarine telegraphy. Ills. 11000 w. Jour Roy U Serv Inst—March, 1908. No. 91499 N.

Telegraph Lines.

The Source of Current for Telegraph Lines (Stromquellen für Telegraphenleitungen). Wenzel Bubenik. A mathematical paper discussing methods of adjusting for variations in insulation resistance. Ills. 2000 w. Elektrotech u Maschinenbau—March 15, 1908. No. 91565 D.

Telegraph Offices.

The New Imperial Central Telegraph Office in Vienna (Die neue k. k. Telegraphen-zentrale in Wien). Illustrated description of the building and equipment. 2500 w. Serial. 1st part. Elektrotech u Maschinenbau—March 22, 1908. No. 91567 D.

Telegraphy.

See Submarine Telegraphy, under COMMUNICATION.

Telephone Exchange.

The New Gerard Exchange of the National Telephone Company. Illustrated detailed description of a London exchange. 2000 w. Elec Engr, Lond—April 10, 1908. Serial. 1st part. No. 91812 A.

Telephone Lines.

Private Telephone Installations (Les Installations de Téléphonie Privée). J. A. Montpellier. A discussion of the design of small local lines and of the appliances available. Ills. 3000 w. Serial. 1st part. L'Elecn—March 14, 1908. No. 91523 D.

Telephony.

The Effects of Leakance and the Use of Heaviside's Distortionless Condition

in Telephone Transmission. B. S. Cohen. Shows that all lines should be kept at the highest practical insulation point consistent with due economy. 1000 w. Elect'n Lond—April 10, 1908. No. 91813 A.

DISTRIBUTION.

Choking Coils.

Choking Coils. Explains their use to reduce voltage where alternating current is used. 1500 w. Prac Engr—April 3, 1908. No. 91661 A.

Wiring.

Looping. Donald S. Munro. Discusses modern practice in wiring. 2500 w. Elec Rev, Lond—April 17, 1908. No. 91876 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Discussion on "The Non-Synchronous Generator in Central Station and Other Work." "Some Developments in Synchronous Converters." "Some Features of Railway Converter Design and Operation," at New York, February 14, 1908. Three papers by W. L. Waters, Charles W. Stone, and J. E. Woodbridge, are discussed together. 7500 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91703 D.

See also High Speed, under DYNAMOS AND MOTORS.

A. C. Motors.

The Sandycroft Foundry Company, Limited, Chester. Illustrates and describes the products of this English works manufacturing electrical machinery. 2500 w. Elec Engr, Lond—April 3, 1908. No. 91666 A.

Some Points in the Connecting and Repairing of Alternating-Current Motors. M. O. Buckley. Explains the grouping and winding of the coils, giving diagrams, and briefly considers the chief troubles of these motors. 2000 w. Elec Age—March, 1908. No. 91287.

Brush Holders.

New Carbon Brush Gear for Turbo-Dynamos. Illustrated description of pneumatic brush-holders and "Morganite" brushes, with report of tests. 800 w. Elec Rev, Lond—March 27, 1908. No. 91459 A.

Commutators.

Truing Up Rotary Commutators. C. L. Greer. Briefly describes two methods. Ills. 500 w. St Ry Jour—April 4, 1908. No. 91349.

D. C. Dynamos.

See High Speed, under DYNAMOS AND MOTORS.

D. C. Motors.

Systematic Designs of Direct Current Stationary Motors. H. O. Eurich and F. P. Whitaker. Read before the Rugby Engng. Soc. Considers the market requirements, general construction, electrical and mechanical design. 2500 w. Mech Engr—April 10, 1908. Serial. 1st part. No. 91810 A.

Frequency Transformers.

Frequency Transformers (Periodenumformer). A. Heyland. Outlines a system of control for induction motors involving the use of a cascade connection and a frequency changer, and enabling the current drawn from the line to be maintained constant. Ills. 2700 w. Serial. 1st part. Elek Kraft u Bahnen—Jan. 4, 1908. No. 91553 D.

Frequency Transformers. A. Heyland. Abstract from *Elek. Kraft, und Bahnen.* Describes a system of control for a. c. induction motors. 1500 w. Elect'n, Lond—April 10, 1908. No. 91814 A.

High Speed.

High-Speed Electrical Machinery. Gerald Stoney and A. H. Law. Traces the progress of the high-speed dynamo from its first inception, also describes some of the important features of modern types. Ills. 5000 w. Inst of Elec Engrs—March, 1908. No. 91664 N.

Railway Motors.

Discussion on "A Single-Phase Railway Motor," at New York, January 10, 1908. Discusses the paper by E. F. Alexanderson. 10500 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91701 D.

Windings.

A New System of Former Winding for Semi-Closed Slots. Briefly outlines methods that have been used, and describes the new system, stating its advantages. 3800 w. Elec Rev, Lond—March 20, 1908. No. 91272 A.

The Magnetomotive Force of Polyphase Windings. B. C. Dennison. Explains a simplified method of calculating the magnetizing effect, and shows its conformity with the results of other methods. 1700 w. Sib Jour of Engng—April, 1908. No. 91909 C.

ELECTRO-CHEMISTRY.

Electro-Plating.

A Method of Electroplating Lace. Illustrated description. 1500 w. Brass Wld—April, 1908. No. 91769.

ELECTRO-PHYSICS.

Alternating Currents.

On the Representation of Alternating Current Phenomena. D. W. Rennie. Explains two methods. 2000 w. Elect'n, Lond—April 3, 1908. No. 91669 A.

Electromagnetic Force.

Electromagnetic Force. A. S. McAllister. Points out that the usual explanation of this phenomenon is misleading. 800 w. Elec Wld—April 11, 1908. No. 91495.

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GENERATING STATIONS.

Accumulators.

See Boosters, under GENERATING STATIONS.

Boosters.

The Pirani Reversible Battery Booster of the Siemens-Schuckert Company (Die umkehrbare Batteriezusatzmachine, Bauart Pirani, der Siemens-Schuckertwerke G. m. b. h.). W. Weissbach. Illustrated description of the construction and operation of this machine which is intended to increase the balancing power of storage batteries. 3000 w. Elek Kraft u Bahnen—March 24, 1908. No. 91562 D.

Central Stations.

New Generating Station of the Merchants Power Co., Memphis, Tenn. Brief illustrated description. 2000 w. Eng Rec—April 11, 1908. No. 91649.

A Small Power Plant. Charles L. Hays. Illustrated description of a small plant at Cassville, Wis., for supplying light and pumping water. 1000 w. Engr, U S A—April 1, 1908. No. 91297 C.

Extensions of Generating Plant at Wolverhampton. Detailed description of new plant made necessary by the growth of the power-load. Ills. 3500 w. Elec Engng—March 19, 1908. No. 91269 A.

Power Station Improvements, Original Devices and Ideas in the West Penn Station at Connellsville, Pa. Illustrates and describes improvements introduced at a station operating an interurban system of more than 150 miles. 3000 w. St Ry Jour—April 4, 1908. No. 91345.

The Central Power-Station of the De Beers Consolidated Mines, Ltd., Kimberley, South Africa. Percy A. Robbins. Illustrated description of the plant and its equipment, and information related. 8700 w. Bul Am Inst of Min Engrs—March, 1908. No. 91708 D.

Construction.

See Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Design.

The Choice of Prime Movers for the Central Station (Sur le Choix du Matérial moteur pour les Stations centrales). J. Izart. A discussion of the advantages of steam power for stations operating under variable load. Ills. 3000 w. L'Elecn—March 21, 1908. No. 91522 D.

Economics.

Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating. H. W. Handcock and A. H. Dykes. Thinks the universal adoption of high-efficiency lamps would be disastrous for current-supply authorities and suggests a modified system of charging. 7000 w. Inst of Elec Engrs—April, 1908. No. 91811 N.

The Relation Between the Cost of Current and the Duration of Service (Ueber den Zusammenhang zwischen Stromkosten und Benutzungsdauer). G. Dettmar. Gives curves showing the variation in the cost of electrical energy for light and power with the amount consumed. Ills. 2200 w. Elek Kraft u Bahnen—March 14, 1908. No. 91559 D.

Great Britain.

Electric Installations in Great Britain (Les Installations électriques en Grande-Bretagne). Describes six of the leading electricity supply concerns, with especial reference to their financial arrangements, the cost of power, profits, etc. 5600 w. Génie Civil—March 7, 1908. No. 91529 D.

Hydro-Electric.

Construction Features of the Hydro-Electric Plant of the Rockingham Power Co. J. S. Viehe. Illustrated detailed description of the reinforced-concrete dam, power house, etc., of this water-power development in North Carolina. 3000 w. Eng Rec—April 4, 1908. No. 91390.

Power Development at Priest Rapids on the Columbia River. C. L. Creelman. Illustrated description of work including a canal, a two-mile embankment, a power house, a wing dam, and a system of gates. 1000 w. Eng Rec—April 4, 1908. No. 91409.

Penstock with Reinforced-Concrete Lining at the Northern Aluminum Works, Shawinigan Falls. Illustrated description of the tunneling and concreting work, executed during a severe northern winter. 4000 w. Eng Rec—April 4, 1908. No. 91401.

Some Considerations on the Recent Project for a Large Hydraulic Development on the Rhone for the Supply of Electricity to Paris (Einige Betrachtungen über das neue Projekt einer grossen Wasserkraftanlage an der Rhone für die Versorgung von Paris mit Elektrizität). Theodor Roehn. A review of the project in the light of experiences in other parts of the world. Ills. 1600 w. Zeitschr f d Gesamte Turbinenwesen—March 10, 1908. No. 91572 D.

See also Accumulators, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Stations.

See Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Operation.

Trouble in Paralleling Generators at a Railway Plant. C. W. Clark. Explains the trouble and its cause. 1200 w. Power—April 14, 1908. No. 91697.

Switchboards.

High-Tension Continuous-Current

We supply copies of these articles. See page 495.

Switch Gear at Hull. Illustrated description of a large switchboard designed especially for this system. 1200 w. Elect'n, Lond—April 3, 1908. Serial. 1st part. No. 91668 A.

Testing.

Test of Medium Capacity Central Station. Howard S. Knowlton. Gives results of a test made on a central station of about 2500 kilowatts normal capacity. 3000 w. Elec Wld—April 4, 1908. No. 91368.

LIGHTING.

Arc Lamps.

The Magnetite Arc. G. M. Dyott. Considers some of the peculiarities of the magnetite arcs and their performance. Also editorial. 3000 w. Elec Wld—April 25, 1908. No. 91886.

Illumination.

Economical and Efficient Plans for Lighting Small Houses. J. R. Cravath and V. R. Lansingh. Suggestions for the lighting of all the common rooms of a small house. Ills. 2500 w. Elec Wld—April 4, 1908. No. 91366.

See also Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Incandescent Lamps.

"Over Shooting": A New Observation on Tungsten Incandescent Lamps. John B. Taylor. Offers an explanation of this phenomenon. 700 w. Elec Wld—April 25, 1908. No. 91888.

Comparative Tests of Carbon, Metallized Carbon and Tantalum Filament Lamps. T. H. Amrine. Gives results of tests. Ills. 6000 w. Univ of Ill, Bul. 19—Sept. 9, 1907. No. 91707 N.

See also Economics, under GENERATING STATIONS.

Terminology.

Inconsistencies in the Present International Terminology Relating to Illumination. Dr. B. Monasch. Abstract from the *Jour. für Gasbeleuchtung.* A criticism and suggestion. 1800 w. Elect'n, Lond—April 17, 1908. No. 91975 A.

MEASUREMENT.

Capacity.

See Cables, under TRANSMISSION.

Dynamo Testing.

Testing Electric Machinery. W. M. Hollis. Gives tests of very general application that do not require many measuring instruments or intricate calculations. 1800 w. Elec Wld—April 4, 1908. No. 91369.

Inductance.

See Cables, under TRANSMISSION.

Instruments.

New Alternate-Current Instruments. W. E. Sumpner, and J. W. Record. Describes instruments in which iron-cored electromagnets are utilized. Ills. 7500 w. Inst of Elec Engrs—March 19, 1908. No. 91338 N.

Laboratories.

The National Physical Laboratory in 1907. A summary of the past year's work in electrical research. 4000 w. Engng—March 27, 1908. Serial. 1st part. No. 91460 A.

Standardizing Laboratory of the Georgia Railway Electric Company. E. P. Peck. Illustrates and describes the equipment and work. 2000 w. Elec Wld—April 11, 1908. No. 91497.

The National Bureau of Standards; the Service That It May Render to Electrical Engineers and Central-Station Companies. Joseph B. Baker. Explains the valuable service that may be rendered at small cost, describes the resources of the bureau, the building and its equipment. Ills. 3500 w. Elec Wld—April 4, 1908. No. 91367.

Metres.

The Meter and Testing Department of the Hartford Electric Light Company. F. W. Prince. Deals with the adjustment, calibration, installation, maintenance, and reading of recording or integrating watt-meters. Ills. 2000 w. Elec Jour—April 1908. No. 91476.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Oscillograph.

The Oscillograph and Its Application. J. A. Johnson. Read before the employees of the Ontario Power Co. Describes the instrument, explaining its work, and the ways it can be used. Ills. 4000 w. Jour Worcester Poly Inst—March, 1908. No. 91626 C.

Power-Factor Meter.

Physical Theory of Power Factor Meter and Synchroscope. A. R. Dennington. An analysis of the field relations which produce the deflections of the pointers, considered from the standpoint of directional tendencies. Also editorial note. 2000 w. Elec Wld—April 11, 1908. No. 91498.

Resistance.

The Measurement of Dielectric Resistances by Means of the Barretter (Die Messung dielektrischer Widerstände mittels des Barretters). Béla Gali. Illustrated description of method, referring principally to tests of telephone cables. 1500 w. Elektrotech u Maschinenbau—March 29, 1908. No. 91568 D.

See also Cables, under TRANSMISSION.

Synchroscope.

See Power-Factor Meter, under MEASUREMENT.

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TRANSMISSION.

Cables.

Splicing Lead-Armored Cables. H. H. Brown. A brief description of the methods followed by the San Francisco Gas & Elec. Co. 1500 w. Cal Jour of Tech —April, 1908. No. 91967.

Economical Pressures for Power Transmission by Underground Cables. J. B. Sparks. Shows how the cost of cables is affected by raising or lowering the working pressure. 2000 w. Elec Engng —April 2, 1908. No. 91663 A.

Capacity Cables. F. J. O. Howe. Shows the errors arising in the measurement of capacity by the methods in general use and gives results of an investigation which led to the design of a combined bridge for resistance, inductance and capacity tests, the operation being simple and the results accurate. 2500 w. Elect'n, Lond—March 20, 1908. Serial. 1st part. No. 91273 A.

See also Resistance, under MEASUREMENT.

Conduits.

The Cost of Building Electrical Conduits in Baltimore, Md. Gives details of the work and a report of costs. Ills. 3500 w. Engng-Con—April 1, 1908. No. 91363.

Insulators.

Porcelain Insulators for High-Voltage Lines. J. A. Sandford, Jr. Considers the requirements of a good insulator, how they are made and tested, and the present tendency. 3500 w. Jour Worcester Poly Inst—March, 1908. No. 91627 C.

Some Notes on High-Tension Insulators for Overhead Transmission Lines. C. J. Greene. Gives results of a series of tests recently made at 100,000 volts on some porcelain insulators of British make. Also statistics of insulators of other countries. 1000 w. Elec Rev, Lond —April 17, 1908. Serial. 1st part. No. 91875 A.

The Electrical Behavior of Insulators for Aerial Transmission Lines and Their Testing (Das elektrische Verhalten der Freileitungsisolatoren und ihre Beurteilung). Gustav Benischke. Describes dangerous conditions which may arise. Ills. 2000 w. Elek Kraft u Bahnen—Jan. 24, 1908. No. 91554 D.

Line Construction.

Overhead Construction for High-Tension Electric Traction or Transmission. Discussion of R. D. Coomb's paper on this subject. Ills. 7800 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91310 E.

Line Design.

The Effect of a Broken Wire on Transmission Line Poles (Ueber dàs Verhalten von Freileitungsgestängen bei Drahtbruch). Ludwig Kallir. A mathematical paper on the design of transmission lines. Ills. 3200 w. Serial. 1st part. Elektrotech u Maschinenbau—March 22, 1908. No. 91566 D.

Lines.

The Installations of the *Sud Electrique* (Les Installations du Sud Electrique). M. Dusaugey. Describes the organization, substations, and lines of a company for the transmission and distribution of electricity, not its generation, over four departments of Southern France. Ills. 1000 w. Bul Soc Int des Elecns—March, 1908. No. 91506 F.

Poles.

Tests and Calculation of Reinforced Concrete Poles of Annular Section (Versuche und Berechnung von Eisenbetonmasten mit ringförmigem Querschnitt). F. Schüle. Gives the results of tests and conclusions drawn from them. Ills. 2600 w. Beton u Eisen—March 12, 1908. No. 91574 F.

Protective Devices

Protective Devices for High-Tension Transmission Circuits. J. S. Peck. Explains some of the disturbances, and describes protective devices now in use. Ills. 4500 w. Inst of Elec Engrs—March, 1908. No. 91860 N.

Rotary Converters.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

Transformers.

The Relation Between Iron and Copper in Transformers. M. Kawara. Gives a graphical synopsis of the costs of material in constructing a particular type of transformer. 300 w. Elec Wld—April 11, 1908. No. 91496.

Vector Algebra for Alternate-Current Problems. William Cramp and C. F. Smith. An explanation of a system that is considered an improvement on that introduced by C. P. Steinmetz. 2500 w. Elec Eng'r, Lond—March 20, 1908. No. 91270 A.

MISCELLANY.

Aluminium.

Is Copper Essential to the Electrical Industry? H. M. Hobart. Gives the writer's views on the possibilities of the use of aluminium. 2000 w. Cassier's Mag—April, 1908. No. 91455 B.

America.

America Revisited, 1907. Sir William Henry Preece. Describes the writer's impressions of developments since a previous visit, especially in electrical fields. 12800 w. Inst of Elec Engrs—March 12, 1908. No. 91337 N.

Copper.

See Aluminum, under MISCELLANY.

Electromagnetic Brakes.

The Design of Electromagnetic Brakes.

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J. Nikonow. Discusses the design of electromagnetic brakes with reference to particular types in practical use. Ills. 3000 w. Elec Wld—April 18, 1908. No. 91732.

France.

The Electrical Industry in France. Georges Dary. Remarks on the peculiarities of temperament that affect industrial enterprise, and gives a general review of the French industrial situation. 3500 w. Elec Rev, Lond—March 20, 1908. Serial. 1st part. No. 91271 A.

INDUSTRIAL ECONOMY

Accounting.

The Development of Bookkeeping on a Mathematical Basis (Die Entwicklung der Buchführung auf mathematischer Grundlage). Paul Beck. Special reference to accounting methods in manufacturing establishments. Ills. 2500 w. Serial. 1st part. Technik u Wirtschaft—March, 1908. No. 91534 D.

See also Civil Engineering, under MARINE AND NAVAL ENGINEERING.

Apprenticeship.

The London 'Prentice, His contemporaries and Successors. George Frederic Stratton. A discussion of the old and new methods of training mechanics. 4000 w. Cassier's Mag—April, 1908. No. 91451 B.

The Crisis of Apprenticeship in France (La Crise de l'Apprentissage dans l'Industrie Française). Georges Courtois. Discusses the cause of its decadence and the remedies proposed. 4000 w. Génie Civil—March 14, 1908. No. 91530 D.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. The first of a series of six articles, considering what constitutes a knowledge of costs. 2500 w. Engineering Magazine—May, 1908. No. 91956 B.

Education.

Technical Education in America. Sir William H. Preece. Describes the Carnegie Institute of Pittsburgh, and other technical colleges, commenting on the American practice. General discussion. 7500 w. Jour Soc of Arts—April 10, 1908. No. 91803 A.

The Importance of English in the Work of the Engineer. William D. Ennis. On the need of practice and training in the use of language. 2000 w. Engineering Magazine—May, 1908. No. 91951 B.

College Training of Electrical Engineers. Prof. Arthur C. Scott. An examination of criticisms of the present system, with discussion and suggestions for changes that the author considers desirable. 4000 w. Elec Wld—April 18, 1908. No. 91733.

Hydraulic Engineering at the University of Wisconsin. Daniel W. Mead. Describes the methods of instruction and the laboratory equipment, research work, etc. General discussion. Ills. 11000 w. Jour W Soc of Engrs—Feb., 1908. No. 91631 D.

Resumed Discussion on Mr. W. G. Spence's Paper on "Notes from Four Years' Working of the Educational Committee's Recommendations." 10500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1908. No. 91750 N.

Progressive Shop Education—A Suggestion. Frederick A. Waldron. Outlines a systematic course to train shop men for the responsibilities of foremen, superintendents or managers. 3000 w. Am Mach—Vol. 31. No. 14. No. 91327.

Methods of Instruction and Examination in the Mechanical Engineering Department of the Danzig Technical High School (Die Ausgestaltung des Unterrichtes und der Prüfungsvorschriften für das Maschineningenieurwesen an der Technischen Hochschule). A Wagener. 5500 w. Zeitschr d Ver Deutscher. Ing—March 7, 1908. No. 91589 D.

Eight-Hour Day.

The Eight-Hour Bill as Related to English Coal Mining. George Raylton Dixon. Describes the conditions which this act proposes to amend, the difficulties, and the writer's solution. 2200 w. Eng & Min Jour—April 25, 1908. No. 91939.

Engineering Ethics.

Concerning Engineers as Members of Commissions. Editorial discussion of the reasons why the policy of appointing engineers on public commissions has led to criticism. 1200 w. Eng News—April 16, 1908. No. 91740.

The Engineer's Activity in Public Affairs—Public Utility Commissions and Franchise Valuations. Henry Floy. Discusses the importance of verifying his conclusions and opinions and determining his line of action that his work may be of value in these fields. 7000 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91699 D.

Engineering Literature.

The Making of Literature for Engineers. Charles Whiting Baker. Address

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before the engineering students of the University of Michigan. 6000 w. Eng News—April 16, 1908. No. 91742.

Management.

General Instructions for Machine-Shop Methods. Holden A. Evans. Describes a system aiming to promote efficiency. 4000 w. Am Mach—Vol. 31. No. 16. No. 91731.

Additional Methods of Tracing the Progress of the Work. Oscar E. Perrigo. Discussion on methods of accurately locating component parts of work in progress. 3000 w. Ir Trd Rev—April 2, 1908. No. 91343.

An Analysis of Machine-Shop Methods. Holden A. Evans. A discussion of causes tending to inefficiency in government shops. 5500 w. Am Mach—Vol. 31. No. 15. Serial. 1st part. No. 91493.

Mechanical Engineering as Practiced on the Atlantic and Pacific Coasts. George W. Dickie. Compares the conditions from an engineering standpoint. 2500 w. Jour Assn of Engng Socs—March, 1908. No. 91725 C.

Maximum Production Through Organization and Supervision. C. E. Knoeppel. This second article of a series considers systematic processing, machining, assembly and erection. 3500 w. Engineering Magazine—May, 1908. No. 91954 B.

See also Drafting, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN; and Pattern Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Patents.

Notes on Patent Procedure. F. W. Blair. Gives information of assistance to inventors. 3000 w. Elec Rev, N Y—April 11, 1908. No. 91616.

Safety Devices.

The New Museum of Safety Devices at Paris. Jacques Boyer. Illustrated description of the collection of the Conservatoire des Arts et Métiers. 3500 w. Engineering Magazine—May, 1908. No. 91953 B.

South America.

The Wealth and Prospective Development of the West Coast of South America. Francis W. Blackford. A descriptive account of the conditions, and problems in developing this region. 3500 w. Jour Assn of Engng Socs—March, 1908. No. 91723 C.

Trusts.

The Proposed Anti-Trust Law Amendment. An analysis by Henry R. Towne of the Hepburn amendment of the Sherman Anti-Trust Act. 2000 w. Ir Age—April 16, 1908. No. 91744.

Waste Products.

The Utilization of Waste Products. F. F. Gairns. Brief discussion of conditions under which economies may be effected. 1500 w. Cassier's Mag—April, 1908. No. 91453 B.

MARINE AND NAVAL ENGINEERING

Armor.

Modern Armor and Its Attack. T. J. Tresidder. Read before the Inst. of Naval Architects. A discussion from the theoretical and analytical point of view. 8000 w. Engng—April 10, 1908. No. 91819 A.

Battleships.

The United States Battleships "Delaware" and "North Dakota." Illustrates and describes these battleships. 1500 w. Sci Am—April 18, 1908. No. 91747.

U. S. Battleships "Mississippi" and "Idaho." Illustrations, with description of machinery and official trials. 2500 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91637 H.

Japanese Battleship "Iwami" as She Was and Is.—A Lesson in "Freeboard." Illustrates and describes the transformation of the Russian "Orel," in which a high-freeboard is changed to a moderate-freeboard, also other changes. 1200 w. Sci Am—April 4, 1908. No. 91372.

Trials of French Battleships. A report of the trials of the four newest battleships of France, with remarks on their special features. 1500 w. Engr, Lond—March 20, 1908. No. 91280 A.

Features of a Battleship Design. H. C. Dinger. Presents new possibilities with the aim of creating discussion and criticism of the various features of the best possible fighting vessel that can be built with a displacement of less than 20000 tons. 7500 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91638 H.

The Question of Speed in Battleships. R. R. Riggs. Considers the military elements of a battleship to be guns, armor and speed, and gives the writer's views of how far the first two should be sacrificed to attain the last. 4000 w. Pro U S Nav Inst—March, 1908. No. 91444 F.

Another Argument for Speed in Battleship Design. Yates Stirling, Jr. Gives an illustration to show the substantial advantage possessed by the faster fleet. 700 w. Pro U S Nav Inst—March, 1908. No. 91445 F.

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Civil Engineering.

The Duties of the Navy Civil Engineers, and Their System of Keeping Cost Accounts. L. F. Bellinger. Describes some of the duties and work, and methods of determining detailed cost. Ills. 5000 w. Cornell Civ Engr—April, 1908. No. 91838 C.

Davits.

Appliances for Manipulating Lifeboats on Sea-Going Vessels. Axel Welin. Considers the principal requirements of an ideal system of davits, and the advantages of the Welin Quadrant type. Ills. 2500 w. Jour Fr Inst—April, 1908. No. 91941 D.

Destroyers.

Torpedo-Boat Destroyer for the Greek Navy. Illustrated description. 600 w. Engng—April 3, 1908. No. 91673 A.

Dry-Docks.

Floating Docks. Harry R. Jarvis. Describes various types of dock, and the class of work performed on them, their advantages and cost. Discussion. 6500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1908. No. 91751 N.

The Contractor's Plant and Methods on Mare Island Dry Dock No. 2. Illustrates difficult work in California, giving details of methods employed on this reinforced-concrete dock. 10500 w. Eng Rec —April 4, 1908. No. 91393.

Fire Boats.

Chicago Fire Boats. Sectional plans with descriptions of two fire boats now being built. 2300 w. Marine Rev—April 2, 1908. No. 91379.

Fleet Steaming.

Fleet Steaming and Economy. H. C. Dinger. Discusses the conditions for obtaining the greatest economy in steaming. 2500 w. Pro U S Nav Inst—March, 1908. No. 91446 F.

Fulton.

Fulton in England. H. N. Dickinson. An illustrated article giving correspondence and unpublished details of early work in England. 4500 w. Cassier's Mag—April, 1908. No. 91448 B.

Gyrostats.

Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling. M. Wurl. Explains the principles underlying the rolling of ships, and the steadying effect of this system of gyroscopes. Discussion. 6500 w. Jour Soc of Arts—April 3, 1908. No. 91654 A.

Launches.

Two New Steam Launches. Illustrations and particulars of the "Constructor" and the "Sirius." 700 w. Engr, Lond—March 27, 1908. No. 91468 A.

Lifeboats.

The Lifeboats of the United Kingdom. Information concerning the types in service, and recent changes aiming at greater efficiency. 1600 w. Engr, Lond—April 17, 1908. No. 91982 A.

Lightships.

Trials of Lightship Number 88. Brief report of trials for the U. S. Government vessel. 500 w. Int Marine Engng—May, 1908. No. 91831 C.

Lusitania.

The Speed of the Cunard Turbine-Steamer "Lusitania." Thomas Bell. Read Before the Inst. of Naval Archts. A brief record of the trials and running in service of this Cunard turbine-steamer. 4500 w. Engng—April 10, 1908. No. 91821 A.

Marine Transport.

Improvement of the American Merchant Marine. William P. Munger. Briefly discusses the various plans proposed to strengthen the service. 1600 w. Sci Am —April 25, 1908. No. 91889.

Mauretania.

The Electrical Equipment of the SS. "Mauretania." Illustrated description of the electrical installation. 2000 w. Elec Rev, Lond—April 3, 1908. Serial. 1st part. No. 91667 A.

Motor Boats.

Motor Yacht Club's Efficiency Trial—A New System. A summary of the rules and regulations for the Fifth Annual Trial. 2200 w. Auto Jour—April 11, 1908. No. 91805 A.

See also Exhibitions, under MECHANICAL ENGINEERING, AUTOMOBILES.

Propellers.

Model Propeller Experiments. An account of the experiments by Prof. Flamm, of the Technisch Hochschule of Berlin. 3500 w. Engr, Lond—April 3, 1908. No. 91675 A.

Repairs.

Practical Hints on Foundry Work. A. E. Roskilly. Suggestions for ordinary replacements by the engineering staff on board a man-of-war while the vessel is away from a naval port. 2000 w. Prac Engr—March 20, 1908. No. 91266 A.

Resistance.

A Contribution to Experimental Research on the Resistance of Water to Moving Bodies (Ein Beitrag zur experimentellen Ermittlung des Wasserwiderstandes gegen bewegte Körper). Fr. Gebers. Gives the results of elaborate experiments with flat plates. Ills. 8000 w. Serial. 1st part. Schiffbau—March 25, 1908. No. 91549 D.

Sails.

Sail Making. Adrian Wilson. Much information in regard to sails and sailing. Ills. 5000 w. Int Marine Engng—May, 1908. Serial. 1st art. No. 91833 C.

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Shipbuilding.

Shipbulding on the Great Lakes. Illustrates and describes the building of modern steel freight steamships of the Great Lakes. 3000 w. Naut Gaz—April 2, 1908. No. 91340.

See also Yachts, under MARINE AND NAVAL ENGINEERING.

Ship Design.

A Few Constructive Details. Details of rudders and frames are given in the present number. Ills. 800 w. Int Marine Engng—May, 1908. Serial. 1st part. No. 91832 C.

Unsolved Problems in the Design and Propulsion of Ships. Francis Elgar. The discussion is limited to the mercantile marine, and considers problems relating to loading, stability, strength, speed, propulsion, vibration, etc. 13000 w. Inst of Civ Engrs—June 18, 1907. No. 91858 N.

Steam Engines.

The Combination System of Reciprocating Engines and Steam Turbines. C. A. Parsons and R. J. Walker. Read before the Inst. of Naval Archts. Considers the general arrangement and estimated economy, and the applications of this system. Ills. 2500 w. Engng—April 17, 1908. No. 91978 A.

See Lusitania, and Mauretania, under MARINE AND NAVAL ENGINEERING.

American Turbines for the Japanese Armored Cruiser "Ibuki." Illustrated description of 27000-h.p. turbines. 1500 w. Sci Am—April 25, 1908. No. 91891.

Steam Turbines.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING; and Torsion Meters, under MECHANICAL ENGINEERING, MEASUREMENT.

Submarines.

New Submersibles for Russia. Illustrated descriptions. 400 w. Engr, Lond—April 17, 1908. No. 91984 A.

Torpedo Boats.

Modern Torpedo Boats and Destroyers. J. E. Thornycroft. Read before the Inst. of Naval Archts. A review of the developments. Ills. 4500 w. Engng—April 10, 1908. No. 91820 A.

U. S. Navy.

The Engineering Situation in the United States Navy. Henry Charles Dinger. A general description of conditions, explaining remedies that appear necessary, and calling attention to proposed plans of remedy which are not based on sound principles. 32500 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91636 H.

Warships.

Unsinkable and Uncapsizable Ships of the Goulaeff Form and System of Construction. E. E. Goulaeff. Read before the Inst. of Naval Archts. An illustrated description of the proposed form, with special reference to warships. 5000 w. Engng—April 10, 1908. No. 91818 A.

Yachts.

New Royal Yacht Alexandra. Illustration and description of this new turbine yacht. 1400 w. Engr, Lond—March 27, 1908. No. 91466 A.

Elongation and Rebuilding of the Royal Danish Steam Yacht Dannebrog. Axel Holm. Illustrated detailed description of alterations, and report of trials. 2200 w. Int Marine Engng—May, 1908. No. 91830 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Arctic Regions.

Motors in the Arctic Regions. H. O. Duncan. Information in regard to climatic conditions and other difficulties to be encountered. 1800 w. Autocar—April 4, 1908. No. 91656 A.

Brooke.

The 40-H.P. 6-Cyl. Brooke Car. Illustrated description of an interesting British car. 1200 w. Auto Jour—March 21, 1908. Serial. 1st part. No. 91262 A.

Carbureters.

The New Sthenos Carbureter. Sectional drawing, with description. 700 w. Autocar—March 21, 1908. No. 91264 A.

Commercial Vehicles.

The Use of Motor Trucks for the Delivery of Coal in Paris (Note sur l'Emploi des Camions automobiles à la Livraison de la Houille, à Domicile, dans Paris). M. Chambelin. Illustrates and describes the side dumping truck used, and gives details of their cost of operation. 1700 w. Rev. Gen d Chemins de Fer—March, 1908. No. 91519 G.

See also Exhibitions, under AUTOMOBILES.

Construction.

Some Observations on Frames and Their Suspension. Illustrated discussion of the construction and suspension of chassis frames. 2800 w. Auto Jour—March 21, 1908. Serial. 1st part. No. 91261 A.

See also Forging, under MACHINE WORKS AND FOUNDRIES.

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Design.

Some Commoner Faults of Auto Design. A. H. Denison. Calls attention to instances of faulty design. 2200 w. Automobile—April 23, 1908. No. 91927.

Electric.

Petrol-Electric Systems. Frost Smith and W. A. Stevens. Abstract of a paper read before the Soc. of Road Trac. Engrs. Brief consideration of the principal systems. 1800 w. Auto Jour—April 4, 1908. No. 91658 A.

Exhibitions.

Commercial Vehicles and Motor-Boats at Olympia. Begins an illustrated description of the interesting exhibits. 3000 w. Engng—April 3, 1908. Serial. 1st part. No. 91672 A.

Fuels.

Benzine or Benzol (Benzin oder Benzol). Karl Dieterich-Helfenberg. A discussion of their relative value as motor fuels. 2500 w. Zeitschr d Mit Motorwagen Ver—Mar. 15, 1908. No. 91579 D.

Garages.

See Concrete Blocks, under CIVIL ENGINEERING, CONSTRUCTION.

Gears.

Epicyclic Gearing for Automobiles. T. A. Borthwick. An illustrated explanation of sun and planet trains for speed-changing. 1500 w. Cassier's Mag—April, 1908. No. 91452 B.

Ignition.

Some E. I. C. Ignition Specialities. Brief illustrated descriptions of interesting devices. 1700 w. Autocar—April 18, 1908. No. 91970 A.

Motors.

Comparison of Four and Six-Cylinder Motors. Arthur H. Denison. Shows that the six-cylinder overcomes many disadvantages of the four-cylinder, though both give excellent service. 1600 w. Automobile—April 2, 1908. No. 91356.

Producer Gas.

A Producer-Gas-Driven Automobile. Describes a vehicle recently subjected to trials in Scotland. 1200 w. Sci Am—April 11, 1908. No. 91607.

Sheffield-Simplex.

The 45 H. P. Sheffield-Simplex Chassis. Illustrated description. 2000 w. Autocar—March 21, 1908. Serial. 1st part. No. 91263 A.

Stanley.

The Stanley Steam Car. Illustrated detailed description. 1200 w. Auto Jour—April 4, 1908. Serial. 1st part. No. 91657 A.

Testing.

Rules for Making Ordinary Tests of Motor Vehicles (Ueber Normen zur typenmässigen Prüfung von Kraftfahrzeugen). Herr Weiss. A general discussion of the tests necessary and methods of conducting them. 2500 w. Zeitschr d Mit Motorwagen Ver—Mar. 15, 1908. No. 91578 D.

Tires.

Non-Skids. An illustrated review of many now on the market. 2000 w. Autocar—April 11, 1908. No. 91806 A.

Wheels.

The British Divisible Rim. Illustrated description of a device aiming to save time and labor in repairing a puncture. 1000 w. Auto Jour—March 28, 1908. No. 91457 A.

COMBUSTION MOTORS.

Crankshafts.

Gas-Engine Shafts. W. H. Booth. Considers gas-engine crank-shaft design and manufacture. 1500 w. Am Mach—Vol. 31, No. 15. No. 91494.

Gas Cleaning.

See Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Engine Governing.

The Governing and the Regularity of Gas-Engines. James Atkinson. Discusses what is commonly called the quality method of governing gas-engines, and also the quantity method, and when each is desirable. Ills. 7000 w. Inst of Mech Engrs—April 10, 1908. No. 91969 N.

Gas-Engine Guarantees.

Gas Engine and Producer Guarantees. Prof. C. E. Lucke. Presents forms of guarantees, with critical remarks, showing the need of action on this question. Also discussion. 4000 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91478.

Gas Engines.

Gas Engines in a Carnegie Steel Plant. Cecil P. Poole. Illustrates and describes three large double-acting Westinghouse units at Bessemer which are being successfully operated under trying conditions. 1800 w. Power—April 28, 1908. No. 91987.

Why the Tandem Double-Acting Gas Engine is Standard. L. B. Lent. Explains the advantages of this type. 1600 w. Power—March 31, 1908. No. 91284.

Gas-Engine Failures and Their Remedies. A. H. Burnand. Gives a number of cases, explaining the troubles and remedies. 2000 w. Mech Wld—April 17, 1908. No. 91870 A.

The Gas Engine's Probable Future. Sumner B. Ely. Considers a satisfactory bituminous gas producer necessary to secure general use. Discussion. 5000 w. Pro Engrs' Soc of W Penn—March, 1908. No. 91625 D.

The Effect of Mixture Strength and Scavenging Upon Thermal Efficiency.

Bertram Hopkinson. Gives results of investigations regarding the efficiency of a 40 h.p. Crossley gas engine. 9500 w. Inst of Mech Engrs—April 10, 1908. No. 91968 N.

Improvements in Large Gas Engines (Perfectionnements aux gros Moteurs à Gaz). Dr. Handorff. From the *Zeitschrift des Vereines Deutscher Ingenieure.* Discusses recent advances. Ills. 6000 w. All Indus—Mar., 1908. No. 91525 D.

See also Crankshafts, under COMBUSTION MOTORS; and Power Plants, under POWER AND TRANSMISSION.

Gasoline Engines.

The Dufaux Aerial Petrol Motor. Illustrated description of an extremely light and powerful engine for aerial work. 700 w. Auto Jour—April 11, 1908. No. 91804 A.

Gas Power Plants.

South American Gas-Power Plants. Illustrated account of the producer installations at Banfield and at Liniers, successfully operated on bituminous slack coal. 1000 w. Power—March 31, 1908. No. 91283.

A Satisfactory Producer-Gas Plant. F. C. Tryon. An account of a plant in Brooklyn, N. Y. 2200 w. Power—April 21, 1908. No. 91828.

See also Pumping Plants, under HYDRAULIC MACHINERY; and Power Plants, under POWER AND TRANSMISSION.

Gas Producer By-Products.

Ammonia Recovery in Connection with Producer Gas. F. J. Rowan. Reviews the practice and investigations in gas works, and the application to gas producers. 5500 w. Jour W of Scotland. Ir & St Inst—Jan., 1908. No. 91919 N.

Gas Producers.

The Rational Utilization of Low Grade Fuels in Gas Producers. F. E. Junge's paper is discussed. 4500 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91480.

Poor-Gas Producers (Les Gazogènes à Gaz Pauvre). L. Letombe. An elaborate paper, discussing their design, determination of calorific power of gas, the historical development of the gas producer, the latest types, gas cleaning, etc. Ills. 23000 w. Mem Soc Ing Civ de France —Jan., 1908. No. 91504 G.

The Production of Power Gas and the Construction of Producer Plants (Die Kraftgaserzeugung und die Construction von Kraftgas-Generatoranlagen). J. Schmidt. A general discussion of producer plant construction and practice. Ills. 4000 w. Serial. 1st part. Elektrotech u Polytech Rundschau—Mar. 4, 1908. No. 91569 D.

Gas Tables.

Gases: Tables and Constants. George C. Stone. Gives tables calculated by the writer on the weight, thermal capacities, etc., of gases. 1200 w. Sch of Mines Qr —April, 1908. No. 91915 D.

Gas Testing.

A Simple Continuous Gas Calorimeter. C. E. Lucke. Discusses this problem, presenting a method of solving it. Also discussion. Ills. 3000 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91479.

Gas Turbines.

Recent Developments in the Gas Turbine. Alfred Barbezat. An illustrated article giving records of actual experience with operative machines. 1500 w. Cassier's Mag—April, 1908. No. 91450 B.

Oil Engines.

See Air Compressors, under POWER AND TRANSMISSION.

HEATING AND COOLING.

Air Washers.

The Development of the Air Washer. Thomas Barwick and Sam. Kauffman. A discussion, illustrating and describing types. 2000 w. Heat & Vent Mag—April, 1908. No. 91772.

Cooling Towers.

The Capacity of Cooling Towers. C. O. Schmitt. Reply to the discussion of the writer's paper on this subject. Ills. 3500 w. Jour S African Assn of Engrs —Feb., 1908. No. 91260 F.

Electric Heating.

Cooking and Heating by Electricity (Das Kochen und Heizen mit Elektricität). A general review of advances and results in this field. Ills. 2500 w. Serial. 1st part. Elektrotech u Polytech Rundschau—Mar. 26, 1908. No. 91570 D.

Hot-Air Heating.

Heating and Ventilating a Bank. Illustrates and describes an upward system installed in the First National Bank in Boston. 1000 w. Heat & Vent Mag—April, 1908. No. 91773.

Furnace Heating of a 32-Room Residence. Detailed description of case of two separate furnaces for a single building. Ills. 3000 w. Met Work—April 25, 1908. No. 91925.

Hot-Water Heating.

The Calculation of Pipe Lines for Hot-Water Heating Plants (Die Berechnung der Rohrleitungen von Warmwasserheizanlagen). M. Haller. A practical discussion. Ills. 3300 w. Gesundheits-Ing—Mar. 14, 1908. No. 91586 D.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Refrigeration.

Mechanical Refrigeration. M. G. Anderson. Read before the Manchester Assn. of Engrs. Discusses the principles

of refrigeration, the plant and testing arrangements, and results. 5000 w. Mech Engr—April 10, 1908. No. 91809 A.

Minor Details in an Absorption Plant. William S. Luckenbach. Suggestions for care that will lessen cost and increase efficiency. 1800 w. Power—April 28, 1908. No. 91989.

Advantages of Absorption Refrigerating Machines. Heywood Cochran. An explanation of this system, with a statement of the advantages claimed. Discussion. Ills. 6500 w. Ice & Refrig—April, 1908. No. 91488 C.

The Ammonia Compression System. George Norden. Arguments in favor of this system. 2000 w. Ice & Refrig—April, 1908. No. 91487 C.

Test of Compressor. Charles E. Lucke. Gives details of tests on a 50-ton De La Vergne oil compressor to determine the horse-power per ton refrigeration. Ills. 3500 w. Ice & Refrig—April, 1908. No. 91489 C.

Steam Heating.

Progressive Heating. Jno K. Allen. First of a series of elementary papers on the best applications of steam and water for producing artificial heat. 2000 w. Dom Engng—April 11, 1908. Serial. 1st part. No. 91680.

Heating and Ventilation of the New Forrest Theater, Philadelphia, Pa. Heated by steam on the low-pressure system, using both indirect and direct radiation. Ventilation by upward flow. 3000 w. Eng Rec—April 25, 1908. No. 91935.

Back Pressures in a Factory Heating Plant. John C. White. Increasing the back pressure is found to add little to the heating capacity, while it reduces the efficiency. 3000 w. Power—April 14, 1908. No. 91696.

Summer Care of Heating Plants. Directions for putting steam and hot-water plants into such condition as will prevent their being harmed by months of disuse. 1000 w. Dom Engng—April 4, 1908. No. 91411.

Ventilation.

See Hot-Air Heating and Steam Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Accumulators.

Hydraulic Accumulators in Power Plants (Ueber hydraulische Akkumulierungsanlagen bei Kraftwerken). Artur Budau. A discussion of their utility in plants operating under variable load. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver —Mar. 13, 1908. No. 91582 D.

Centrifugal Pumps.

Centrifugal Pumps. G. F. Blessing. The present article gives a classification; and subsequent articles will deal with characteristics and constructive features, operation, etc. Ills. 2500 w. Sib Jour of Engng—April, 1908. Serial. 1st part. No. 91907 C.

Tests of a Centrifugal Pump (Versuche an einer Zentrifugalpumpe). Ernst Reichel. Illustrated description of pump, tests, and results. Tables. 4000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Mar. 10, 1908. No. 91571 D.

The Operation of Centrifugal Pumps and Fans (Die Wirkungsweise der Kreiselpumpen und Ventilatoren). R. Biel. Gives a mathematical discussion of their theory and describes and analyses the results of elaborate tests. Ills. 4800 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Mar. 21, 1907. No. 91500 D.

Electric Pumping.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE; and Pumping, under MINING AND METALLURGY, MINING.

Laboratories.

See Education, under INDUSTRIAL ECONOMY.

Pumping Plants.

Experience with a Producer Gas Plant. Harry L. Thomas. An account of experience in pumping water with a gas-producer plant. Ills. Discussion. 6500 w. Jour N Eng W-Wks Assn—March, 1908. No. 91719 F.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Pumping, under MINING AND METALLURGY, MINING.

Pumps.

Proper Thickness of a Valve Deck in a Pump. F. F. Nickel. A criticism of a proposed plan, with suggestions. Ills. 900 w. Power—April 21, 1908. No. 91826.

A Test of the Screw Pump for Flushing the Kinnickinnic River at Milwaukee, Wis. Report of tests made of a river-flushing plant. 900 w. Eng News—April 23, 1908. No. 91883.

Turbine Governing.

The Governing Action of Modern Indirect Hydraulic Turbine Governors (Der Reguliervorgang bei modernen indirekt wirkenden hydraulischen Turbinenregulatoren). R. Löwy. A discussion of the action of a number of types of indirect-acting governors. Ills. 4000 w. Serial. 1st part. Elektrotech u Maschinenbau—Mar. 1, 1908. No. 91564 D.

Turbines.

Water Flow in the Runner of a Francis Turbine (Die Strömung im Laufrad einer Francisturbine). R. Löwy. A mathematical and theoretical discussion. Ills. 2000 w. Serial. 1st part. Zeitschr

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f d Gesamte Turbinenwesen—Mar. 30, 1908. No. 91573 D.

MACHINE ELEMENTS AND DESIGNS.

Bearing Caps.

Proportions of Connecting-Rods and Bearing Caps. Charles H. F. Lubcke. Shows the application of the bending formula to bearing caps. 1000 w. Power—April 28, 1908. No. 91988.

Chains.

The Strength of Chain Links. G. A. Goodenough and L. E. Moore. A report of experimental work, deriving formulæ for the loading of chains. Ills. 11000 w. Univ of Ill, Bul 18—Sept., 1907. No. 91-834 N.

Crankshafts.

See same title, under COMBUSTION MOTORS.

Drafting.

Efficiency in Drawing-Room Practice. H. S. Knowlton. Suggests methods of increasing output and reducing costs. 2000 w. Cassier's Mag—April, 1908. No. 91449 B.

Flywheels.

Effect of Speed Variation on Flywheel Spokes. E. Wagner. Shows a way to demonstrate the bending strain caused by acceleration and retardation. 900 w. Power—April 28, 1908. No. 91991.

Stresses.

Similar Structures with Corresponding Loads. A. Inokuty. Discusses structures where stresses due to their own weights must be considered. Mathematical. 2000 w. Prac Engr—April 3, 1908. No. 91-660 A.

MACHINE WORKS AND FOUNDRIES.

Brass Founding.

Producing High Grade Brass Goods. Joseph H. Glauber. Read before the Metal Workers' Club, at Buffalo. The care and personal attention needed in the manufacture. 2500 w. Met Work—April 25, 1908. No. 91926.

Case Hardening.

Making Case-Hardening Carbon from Waste Leather. Walter J. May. Describes the method of preparation. 1400 w. Prac Engr—April 3, 1908. No. 91-659 A.

Case-Hardening. G. Shaw-Scott. Abstract of a paper read before the Iron and Steel Inst. at Vienna, with additional notes. Ills. 2000 w. Autocar—April 18, 1908. No. 91971 A.

Castings.

Steam. H. Sayers. Discusses the effects of steam in the mold, and the remedy. 1500 w. Foundry—April, 1908. No. 91288.

Ornamental Gray Iron Castings. H. Cole Estep. Illustrated description of the practice followed in a new plant in Minneapolis. 2500 w. Foundry—April, 1908 No. 91291.

Malleable Iron Castings. C. H. Gale. Read before the Pittsburgh Found. Assn. A comparison of furnaces used and methods of annealing. 2200 w. Ir Age—April 23, 1908. No. 91885.

The Production of Malleable Castings, by the Fusion of Wrought Iron in Crucibles. E. C. Ongley. Describes this process, giving its cost, reporting tests, and the applications of this material. Appendices and discussion. 9500 w. Jour W of Scotland Ir & St Inst—Nov., 1907. No. 91917 N.

See also Alloy Steels, and Malleable Iron, under MATERIALS OF CONSTRUCTION.

Construction.

Engineering Organization in the Building of Industrial Plants. Frederic W. Bailey. Discusses the advantages and shows the higher economy secured by designing engineers and constructors. 5000 w. Engineering Magazine—May, 1908. No. 91955 B.

Core Ovens.

Core Ovens for Light and Heavy Work. B. F. Fuller. Read before the Pittsburg Found. Assn. Considers ovens for light and heavy work. 1200 w. Foundry—April, 1908. No. 91290.

Cupola Charging.

Charging Machine for Cupolas. G. R. Brandon. Read at meeting of the Pittsburg Found. Assn. Illustrates and describes machines in successful operation. 1500 w. Foundry—April, 1908. No. 91292.

Dies.

Compound Dies for Sheet-Metal Punchings. K. S. Allen. Explains details of construction. Ills. 700 w. Am Mach—Vol. 31, No. 15. No. 91491.

Drilling Machines.

A New 16-Spindle Drill. Illustrated description. 500 w. Sci Am Sup—April 25, 1908. No. 91893.

Forging.

About Forgings for Automobile Work. Richard W. Funk. Read before the Soc. of Auto. Engrs., Boston. Gives facts showing the effects of certain forging methods on nickel chrome steel as compared with the processes known as hydraulic and drop-forging. 800 w. Automobile—April 2, 1908. No. 91357.

Forging Presses.

The Davy Combined Steam and Hydraulic Forging Press. Illustrates and describes improvements made in this press with the object of expediting the action. 2500 w. Prac Engr—March 20, 1908. No. 91265 A.

Foundry Furnaces.

Electric Furnaces for the Iron and

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Brass Foundry. John B. C. Kershaw. Points out some of the advantages resulting from the use of electricity, and illustrates and describes forms of furnace which might be employed. 2500 w. Elec Wld—April 25, 1908. No. 91887.

Foundry Practice.

Jobbing Steel Foundry Practice. Methods pursued in the new plant of the Bucyrus Steel Casting Co. are illustrated and described. 2500 w. Foundry—April, 1908. No. 91294.

The Development of Ornamental Iron Founding (Zur Entwicklungsgeschichte des Eisenkunstgusses). Julius Lasius. A historical review of methods and achievements in this field. Ills. 3500 w. Stahl u Eisen—Mar. 18, 1908. No. 91540 D.

See also Brass Founding, Castings, and Molding, under MACHINE WORKS AND FOUNDRIES; and Repairs, under MARINE AND NAVAL ENGINEERING.

Galvanizing.

The Protection of Iron and Steel Surfaces by Means of Zinc. Sherard Cowper-Coles. Gives details and comparisons between four different methods of coating iron with zinc. Ills. 3500 w. Elec-Chem & Met Ind—May, 1908. No. 91962 C.

Gear Cutting.

Bevel-Gear Planing Attachment for the Shaper. Illustrated detailed description of an attachment for planing bevel gears. 700 w. Am Mach—Vol. 31, No. 17. No. 91872.

A Study in Spirals. Walter Gribben. Considers the table setting when cutting a spiral gear in a milling machine. Ills. 1200 w. Mach, N Y—April, 1908. No. 91353 C.

Grinding.

Grinding and Grinding Machines. Carl Olson. Considers the influence of vibrations, speed, depth of cut, the grinding wheel, external and internal grinding, etc. Ills. 4500 w. Mach, N Y—April, 1908. No. 91325 C.

Grinding Machines.

Some Grinding Machine Troubles and What Causes Them. Jas. N. Heald. Describes various experiences. 2000 w. Am Mach—Vol. 31, No. 15. No. 91490.

Jigs.

Jigs and Fixtures. Einar Morin. Explains the object and use of these devices, their fundamental principles of design, etc. Ills. 4500 w. Mach, N Y—April, 1908. No. 91324 C.

Machine Tools.

See Time Recorder, under MEASUREMENT.

Management.

See same title, under MACHINE WORKS AND FOUNDRIES.

Milling Cutters.

The Manufacture and Upkeep of Milling Cutters. W. H. Booth. Describes the annealing process and the finishing. 800 w. Am Mach—Vol. 31, No. 16. No. 91729.

Molding.

Gravity Molding. James Cooke Mills. Illustrates and describes the method. 1200 w. Brass Wld—April, 1908. No. 91770.

Molding a Three-Parted Job in a Two-Parted Flask. W. W. McCarter. Illustrated description of method. 600 w. Am Mach—Vol. 31, No. 17. No. 91873

Molding a Cast-Steel Clam-Shell. H. J. McCaslin. Illustrates and describes a method of molding skeleton pattern work. 2500 w. Foundry—April, 1908. No. 91289.

Molding Sands.

Notes on Molding Sands and Their Employment in the Foundry (Notes sur les Sables à Mouler et sur leur Emploi en Fonderie). M. Vinsonneau. The second part of a paper published in April, 1906, dealing with the mixing of sands and their regeneration. Ills. 4800 w. Rev de Métal—Mar., 1908. No. 91515 E + F.

Pattern Making.

Patterns for Special Pipe Flanges. F. W. Barrows. Considers the standards in use, making a plunge, method of laying out, and combination patterns. Ills. 1600 w. Am Mach—Vol. 31, No. 16. No. 91730.

Pattern Shops.

A Practical Pattern Shop System. Oscar E. Perrigo. Explains a simple method of recording patterns. 3000 w. Foundry—April, 1908. No. 91293.

Pipe Founding.

Casting Pipes in Permanent Molds. Edgar A. Custer. Illustrated detailed description of a process and apparatus used by the Tacony Iron Co. 5000 w. Ir Age—April 16, 1908. No. 91743.

See also Pattern Making, under MACHINE WORKS AND FOUNDRIES.

Planing Machines.

Electrically-Driven 14-ft. Planing-Machine. Illustrated description of a machine-tool built by the Niles-Bement-Pond Co. Plates. 2000 w. Engng—April 17, 1908. No. 91979 A.

Safety Devices.

See Textile Machinery, under MISCELLANY; and Safety Devices, under INDUSTRIAL ECONOMY.

Shop Heating.

Hot-Water Heating for a Machine Shop. Illustrated description of an independent heating plant at a shop in Jersey City. 2500 w. Met Work—April 4, 1908. No. 91378.

The Heating and Ventilation of Indus-

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trial Buildings (Chauffage et Ventilation des Etablissements industriels). L. Gérard. Describes a recent installation in a Berlin establishment. Ills. 2000 w. L'Elecn—Mar. 28, 1908. No. 91524 D.

Shop Hygiene.

The Hygiene of the Pottery Trade. William Burton. Explains the difficulties and dangers in connection with the manufacture of pottery, and the present position of this industry in its influence on the health of the workers. Ills. 8000 w. Jour Soc of Arts—March 27, 1908. No. 91472 A.

Improvements in Sand-Blast Machines (Les Améliorations réalisées dans les Machines à Jet de Sable). E. Barbet. Discusses methods of removing the dust from the air breathed by the workman. Ills. 1600 w. Rev d'Econ Indus—Mar. 16, 1908. No. 91505 D.

Methods of Quantitative Determination of Dust (Zur Methodik der quantitativen Staub- und Russbestimmung). Dr. Martin Hahn. Describes the methods and devices used in Germany for determining dust in air. Ills. 4000 w. Gesundheits-Ing—Mar. 14, 1908. No. 91587 D.

Shop Practice.

Building Automobiles in New York City. Illustrates and describes some of the tools, fixtures and methods used in building motor cars. 3000 w. Am Mach—Vol. 31, No. 16. No. 91728.

Shops.

The Hungarian State Engineering Works. Gives a résumé of the origin of these works at Buda Pesth, with plan and illustrated description. 4500 w. Engr, Lond—March 27, 1908. Serial. 1st part. No. 91462 A.

Developments in Austrian Steel Works (Neues in Oesterreichischen Eisenhüttenwerken). Th. Naske. Describes the Skoda Works, Pilsen. Ills. 1400 w. Serial. 1st part. Stahl u Eisen—Mar. 4, 1908. No. 91537 D.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT, and under STREET AND ELECTRIC RAILWAYS.

Tempering.

Chloride of Barium for Hardening. O. M. Becker. Considers the style of furnace to use, how barium chloride should be handled and its effect when hardening steel tools. Ills. 3000 w. Am Mach—Vol. 31, No. 14. No. 91326.

Tool Making.

Tool Making in a Large Manufacturing Plant. H. C. Barnes. Describes methods for the economical productions of jigs, dies, and other appliances made in large quantities. 3500 w. Am Mach—Vol. 31, No. 15. No. 91492.

Woodworking Machines.

A Machine That Saws 240,000 Wooden Paving Blocks in a Day. Jacques Boyer. Illustrated description of the invention by M. Josse. 1200 w. Sci Am—April 18, 1908. No. 91746.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Practical Application of Vanadium to Steel and Iron. J. Kent Smith. Considers the best methods of incorporating this metal. 2000 w. Ir Trd Rev—April 2, 1908. No. 91342.

Vanadium in Steel Castings. E. F. Lake. Explains the properties given to steel castings by addition of vanadium, with some of the tests made, and how it is added to the metal. Ills. 1500 w. Am Mach—Vol. 31, No. 14. No. 91328.

See also Forging, under MACHINE WORKS AND FOUNDRIES.

Cast Iron.

Some Uses of Chilled Castings. Walter J. May. Remarks on their utilization in other ways than those generally adopted. 700 w. Prac Engr—April 17, 1908. No. 91972 A.

See also Malleable Iron, under MATERIALS OF CONSTRUCTION.

Malleable Iron.

Malleable Cast Iron: Its Evolution and Present Position in the Metallurgical World. William Herbert Hatfield. Aims to raise the position of this material, showing its physical properties and general usefulness. Ills. 4000 w. Trans Inst of Engrs & Shipbldrs in Scotland—March 17, 1908. No. 91339 N.

Metallography.

Summary of a Lecture on the Crystallization of Metals. Prof. Thomas Turner. Explains the usual system of classification of crystals, considering different varieties and the circumstances under which they originate. Ills. 3000 w. Jour W of Scotland Ir & St Inst—Oct., 1907. No. 91916 N.

The Constituents of Steel (Les Constituants des Aciers). Henry Le Chatelier. An attempt to give a simple definition of the various constituents recognized in the metallographic study of steel. 2500 w. Rev de Métal—Mar., 1908. No. 91517 E + F.

Steel.

See same title, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Wastes.

Metal Wastes. Dr. Theodor Koller. Trans. from *Verwertung von Abfallstoffen aller Art.* Describes methods of separating mixed chips, and uses made of alloy wastes. 1500 w. Sci Am Sup—April 4, 1908. No. 91374.

MEASUREMENT.

Dovetails.

Measuring Dovetail Slides, Gibs and V's. Frank H. Scheu. Application of wires of known diameters in the accurate measurement of male and female dovetails and V's of various angles. 1000 w. Am Mach—Vol. 31, No. 17. No. 91874.

Hardness.

The Schuchardt & Schutte Steel Hardness Tester. Illustrated description of an electro-magnetic instrument for determining certain properties of iron and steel. 1800 w. Ir Age—April 9, 1908. No. 91485.

Laboratories.

See same title, under ELECTRICAL ENGINEERING, MEASUREMENT.

Pyrometry.

Modern Methods of Temperature Measurement. Illustrated descriptions of types of instruments at present in use. 2000 w. Prac Engr—March 27, 1908. Serial. 1st part. No. 91458 A.

Time Recorder.

A Time Recorder for Machine Tools. N. D. Chard. An illustrated description of an instrument for recording the actual cutting and idle time of machine tools and other machines. 1000 w. Am Mach—Vol. 31, No. 16. No. 91727.

Torsion Meters.

Torsion-Meters, as Applied to the Measurement of the Horse-Power of Marine Steam Turbines. J. Hamilton Gibson. Briefly examines and describes some of these instruments and their application. Plates. 5000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1908. No. 91752 N.

POWER AND TRANSMISSION.

Air Compressors.

The Problem in Air Compression. Prof. Joseph H. Hart. A general discussion of important features, such as inadequate efficiency, and lack of isothermal compression, and the advantages of mechanical refrigeration of the air. 2800 w. Power—April 28, 1908. No. 91990.

Corliss Inlet Valves on Air Compressors. H. V. Conrad. Directions for setting them with diagrams illustrating the two principal forms of Corliss air-valve drive. 1000 w. Power—April 14, 1908. No. 91695.

Test of a Mietz & Weiss Oil Engine Air Compressor. Describes the oil engine and a test of the oil consumption, and the special features and tests of the air compressor. Ills. 3000 w. Ir Age—April 9, 1908. No. 91486.

Air Compressor Plant for East River Tunnels of the Pennsylvania Railway. A. D. Williams, Jr. Illustrates and describes the large Manhattan plant. 1800 w. Engr, U S A—April 1, 1908. No. 91295 C.

The Hydraulic Air Compressing Plant in the Clausthal District (Die hydraulische Luftkompressionsanlage der Kgl. Berginspektion Clausthal). P. Bernstein. Illustrated description with details of costs. 2000 w. Glückauf—Mar. 14, 1908. No. 91547 D.

Compressed Air.

See same title, under MINING AND METALLURGY, MINING.

Costs.

The Cost of Power in Small Units. William E. Snow. Gives data of actual cost of installation and operation compiled from the results of about thirty steam plants. 1000 w. Engineering Magazine—May, 1908. No. 91948 B.

See also Power Plants, under POWER AND TRANSMISSION.

Electric Driving.

An English Electrically-Driven Cement Works. An illustrated description of works at Haverton Hill, Eng., driven by three-phase induction motors. 2000 w. Eng Rec—April 11, 1908. No. 91647.

Economy and Cleanliness in Packingtown—Electricity an Important Factor. C. A. Tupper. Illustrates and describes some of the many applications of electricity in the stockyards and industrial plants. 2200 w. Elec Rev, N Y—April 25, 1908. No. 91901.

Notes on Individual Electric Driving (Notizen über elektrische Einzelantriebe). Wilhelm Kübler. A general discussion of its economic aspects. 2700 w. Elek Kraft u Bahnen—Mar. 4, 1908. No. 91558 D.

The Driving of Machines of Periodically Varying Power by Three-Phase Motors (Antrieb einer Arbeitsmaschine mit periodisch schwankendem Kraftbedarf durch einen Drehstrommotor). Philipp Ehrlich. Discusses the dynamic phenomena in the driving of pumps, compressors, etc. Ills. 2200 w. Elektrotech u Maschinenbau—Mar. 1, 1908. No. 91563 D.

Gas Power.

The Dependability of Gas Power. F. C. Tryon. Gives results from two plants, showing their reliability. 2300 w. Power—April 28, 1908. No. 91992.

The Approximate Cost of Gas Power. M. P. Cleghorn. Gives curves showing cost of installing and operating suction and producer gas-power plants, as compared with steam plants. 1200 w. Power—March 31, 1908. Serial. 1st part. No. 91285.

See also Gas Power Plants, under COMBUSTION MOTORS; and Power Plants, under POWER AND TRANSMISSION.

Hydraulic Power.

Modern Hydraulic Machinery. Carl Wigtel. Deals mainly with the production and distribution of the pressure fluid, including pumps, accumulators, and pressure-generating machinery. Ills. 2000 w. Cassier's Mag—April, 1908. Serial. 1st part. No. 91456 B.

Lubricants.

The Chemical and Physical Testing of Lubricants. J. J. Morgan. Explains chemical and physical tests that should be applied to determine the suitability of a lubricant. 2200 w. Prac Engr—March 20, 1908. Serial. 1st part. No. 91267 A.

Power Plants.

Some Interesting Data on Steam and Gas. J. H. Alexander. A comparison of costs and efficiencies. 2700 w. Engr, U S A—April 1, 1908. No. 91299 C.

Isolated Station Records and Cost Accounting. G. F. Gebhardt. An interesting description of a system employed in a large plant at Chicago, with charts and diagrams. 2000 w. Power—April 28, 1908. No. 91993.

The Old and the New in Power-Plant Machinery. Sterling H. Bunnell. Brief discussion of the relative uses of steam turbines and reciprocating engines, and gas engines. 1500 w. Cassier's Mag—April, 1908. No. 91447 B.

Modern Power Plant. George Ness. Showing modern developments as contrasted with earlier ideas, considering boilers, economizers, superheaters, engines, electrical distribution, turbines, etc. Also discussion. 8500 w. Jour W of Scotland Ir & St Inst—Nov., 1907. No. 91918 N.

The Power Plant of the New Addition of the Raritan Copper Works. Frank D. Easterbrooks. Illustrated detailed description. 1600 w. Elec-Chem & Met Ind—May, 1908. No. 91960 C.

Union Terminal at Washington, D. C.—Main Power Plant. Illustrated description of the plant furnishing current for electric lighting in the station and yards, and the compressed air and hydraulic service. 1200 w. Ry Age—April 24, 1908. No. 91946.

The New Power Plant of the Harburg-Vienna United Rubber Company at Harburg (Das neue Kraftwerk der Vereinigten Gummiwarenfabriken Harburg-Wien in Harburg a. d. E.). H. Wille. Illustrated description of a plant supplying electrical energy for light and power in this large establishment. 2200 w. Elek Kraft u Bahnen—Mar. 4, 1908. No. 91557 D.

See also Construction, under MACHINE WORKS AND FOUNDRIES.

Power-Plant Testing.

See Testing, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

STEAM ENGINEERING.

Boiler Management.

Emergency Operations in Boiler Plant. Notes of value to engineers dealing with trying conditions. 1800 w. Elec Engr, Lond—April 17, 1908. No. 91974 A.

Regulation of the Draft of Steam-Boiler Furnaces. W. H. Wakeman. On the making of a simple but correct draft gage, and the value of an automatic damper regulator. Ills. 1500 w. Elec Wld—April 4, 1908. No. 91371.

Increasing the Rate of Heat Absorption by Steam Boilers. Walter T. Ray and Henry Kreisinger. Treats of the practical utilization of the principles governing the transmission of heat from hot gases through plates. 3500 w. Mines & Min—April, 1908. No. 91321 C.

See Flue-Gas Analysis, and Steam Generation, under STEAM ENGINEERING.

Boiler Waters.

Purification of Feed Water in the Management of Boilers (Entretien des Chaudières, Epuration des Eaux). M. Bidaine. Describes the various methods of purification and softening both within and without the boiler, with comments on their efficiency. Ills. 5000 w. Serial, 2 parts. Bul Sci de l'Assn des Elèves—Feb. and Mar., 1908. No. 91501, each D.

See also Power Plants, under POWER STEAM ENGINEERING.

Condensers.

Running Condensing. P. E. Merriam. Considers the action of condensers and their operation. Ills. 2500 w. Engr, U S A—April 1, 1908. No. 91296 C.

The Influence of Air on Vacuum in Surface Condensers. D. B. Morrison. Read before the Inst. of Naval Archts. An account of research work and results. 4500 w. Engng—April 17, 1908. No. 91980 A.

Engines.

A 25,000 Horse-Power Blooming-Mill Engine. James Tribe. Illustrates and describes features involved in the design and construction of a large reversible rolling-mill engine at the Carnegie Steel Works, South Sharon, Pa. 2500 w. Power—April 21, 1908. No. 91825.

See also Power Plants, under POWER AND TRANSMISSION.

Feed-Water Heaters.

Exhaust-Steam versus Live-Steam Heating. Charles A. Howard. A commentary on the method proposed by Prof. Reeve for heating the feed water in power plants. 1000 w. Engineering Magazine—May, 1908. No. 91949 B.

The Substantial Advantages of Steam-Hot Feed Water. Sydney A. Reeve. A

rejoinder to the criticism of Charles A. Howard, with a reply by Mr. Howard. 700 w. Engineering Magazine—May, 1908. No. 91950 B.

Flue-Gas Analysis.

Does It Pay to Equip a Boiler Room with CO_2 Recorders? H. J. Westover. Describes the apparatus, explaining how to install it and the value of the records. 2000 w. Power—April 7, 1908. No. 91441.

Fuels.

Burning Sawdust, Tanbark and Mill Refuse. Gives views of a number of correspondents as to the best methods of handling the material, and the type of furnace required. Ills. 1700 w. Power—April 7, 1908. No. 91443.

Fuel Specifications and Contracts. William D. Ennis. On the value of laboratory tests, and the importance of correct sampling, testing, and analysis. 5500 w. Eng Rec—April 25, 1908. No. 91933.

The Purchase of Coal Under Government and Commercial Specifications, on the Basis of Its Heating Value, with Analyses of Coal Delivered Under Government Contracts. D. T. Randall. A summary of information obtained by the U. S. Geol. Survey. 9000 w. U S Geol Survey, Bul 339—1908. No. 91777 N.

Fuel Testing.

Government Fuel Testing Plant at Denver, Colorado. G. R. Delamater. An illustrated description of the methods employed in making tests and the apparatus used. 3500 w. Mines & Min—April, 1908. No. 91313 C.

Plant Design.

Discussion on "The Ratio of Heating Surface to Grate Surface as a Factor in Power Plant Design," at New York, December 13, 1907. Paper by Walter S. Finlay, Jr., is discussed. 5000 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91700 D.

Plant Management.

Solving Some Power House Problems. George W. Martin. Suggests some "home-made" oil separators, method of preventing water-hammer in a pump, an expansion bolt, etc. 1000 w. Elec Wld—April 4, 1908. No. 91370.

Plants.

See Costs, and Power Plants, under POWER AND TRANSMISSION.

Smoke Prevention.

Smoke Prevention. John W. Krause. Brief review of action taken in various cities, considering the causes of smoke, its prevention, etc. Discussion. 12000 w. Pro Engrs' Soc of W Penn—March, 1908. No. 91624 D.

Steam Generation.

The Formation of Steam. R. H. Smith. An explanation of the method of steam formation and its most economic generation. 3000 w. Engr, Lond—March 27, 1908. No. 91463 A.

Steam Pipes.

See Valves, under STEAM ENGINEERING.

Steam Properties.

Energy from Expansion of Steam. Sidney A. Reeve. Gives charts with explanation of their use. 1100 w. Power—April 21, 1908. No. 91827.

Steam Transmission.

The Heat and Pressure Losses in the Transmission of Saturated and Superheated Steam (Versuche über den Wärme- und Spannungsverlust bei der Fortleitung gesättigten und überhitzten Wasserdampfes). Chr. Eberle. The first part describes the apparatus and methods used in elaborate researches. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Mar. 28, 1908. No. 91592 D.

Superheating.

The Superheating of Steam. Trans. of article by Aimé Witz. Reviews the history of superheating, explaining the theory, and giving results of experiments. 12000 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91635 H.

Turbines.

The Steam Path of the Turbine. Discussion of Dr. C. P. Steinmetz's paper. 1600 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91482.

Design of a 400-Kilowatt Reaction Turbine. Henry F. Schmidt. Discusses forms of blades and spacers and methods of insertion. 2000 w. Engr, U S A—April, 1908. No. 91298 C.

Guide-Bearings, Oil Distribution, and Carbon Packing in Curtis Turbines. F. L. Johnson. Considers important points in securing a perfect running balance. 1000 w. Power. April 14, 1908. No. 91698.

The Steam Turbine (Les Turbines à Vapeur). V. Marmor. A mathematical discussion of the flow of steam and of the thermodynamics of the steam turbine. Ills. 6000 w. Serial. 1st part. Rev de Mécan—Mar. 31, 1908. No. 91527 E + F.

See also Power Plants, under POWER AND TRANSMISSION, and Steam Turbines, under MARINE AND NAVAL ENGINEERING.

Turbine Valves.

Setting the Valves of the Curtis Turbine. F. L. Johnson. Explains the purpose of the stage valve, discussing possible troubles with mechanical valve-gear, and the remedies, adjusting the governor, etc. Ills. 1600 w. Power—March 31, 1908. No. 91286.

Valve Gears.

A Handy Slide-Valve Diagram. H. J. Zeiper. Gives a convenient diagram with

explanation of its use. 1800 w. Power—April 21, 1908. No. 91829.

Distributing Valve Reversing Gears (Sur les Distributions par Tiroirs à Changement de Marche). L. Detrez. A mathematical treatment of the general features of their design and descriptions of several types. 5200 w. Bul Sci de l'Assn des Elèves—Mar., 1908. No. 91502 D.

Valves.

Automatic Steam Pipe Isolation Valves (Rohrbruchventile). Georg W. Kochler. Illustrates and describes a large number of types. 5500 w. Zeitschr d Ver Deutschr Ing—Mar. 14, 1908. No. 91591 D.

Valve Setting.

How to Set the Valves of a Putnam Engine. F. L. Johnson. Illustrated description of the valve-gear, with directions for setting the valves. 8000 w. Power—April 14, 1908. No. 91693.

Valve Setting for the Greene-Wheelock Engine. Hubert L. Collins. Illustrated description of the Wheelock valve-gear, with the Greene and Hill modifications, and detailed directions for adjusting. 2500 w. Power—April 7, 1908. No. 91440.

TRANSPORTING AND CONVEYING.

Cableways.

Formulas for the Design of Cableways. Edward B. Durham. Discussion of aerial tramways with a study of the derivation of formulae for cable curves. 3000 w. Eng News—April 16, 1908. No. 91736.

Characteristics of Wire Rope Tramways with Some Figures on Cost of Operation. W. S. Gemmert. A brief description of the leading systems. 2000 w. Engng-Con—April 29, 1908. No. 92043.

Wire Ropeway in the North Argentine Cordilleras. Gives a brief account of the valuable mines in the Cordilleras, and the difficulties of transportation, illustrating and describing the wire cableway which has been constructed to give communication to the shipping ports. It is chiefly intended for the conveyance of ores from the mines to the railway, but has been put to other uses. Ills. 3500 w. Engng—March 20, 1908. Serial. 1st part. No. 91275 A.

Car Dumping.

The Hulett Moving Car Dumper. Illustrates and describes this car dumper and its operation. 1700 w. Ir Age—April 30, 1908. No. 92010.

Conveyors.

The Problem of the Spiral Conveyor. F. Webster. Describes the method of laying out the flights. 1000 w. Mach, N Y—April, 1908. No. 91323 C.

Cranes.

5-Ton Electric Overhead Travelling Jib-Crane. Illustrated description of a crane of special design and its operation. 1400 w. Engng—March 20, 1908. No. 91277 A.

The Storehouse of the South German Danube Navigation Company in Vienna (Lagerhaus der Süddeutschen Donau-Dampfschiffahrts-Gesellschaft in Wien). R. Dub. Illustrates and describes the crane equipment. 1600 w. Zeitschr d Ver Deutscher Ing—Mar. 7, 1908. No. 91588 D.

See also Ore Handling, under TRANSPORTING AND CONVEYING.

Derricks.

A Light, Long Steel Derrick Boom. Illustrated detailed description, of interest on account of its unusual reach and lightness. 900 w. Eng Rec—April 18, 1908. No. 91781.

Elevators.

The High-Pressure Hydraulic Elevator. William Baxter, Jr. Illustrated explanation of the operation of the main and pilot valves of the Otis vertical elevator, including the electrical control sometimes employed. 1200 w. Power—April 7, 1908. No. 91442.

Material Handling.

Hoisting Machinery for the Handling of Materials. T. Kennard Thomson. This third and concluding article illustrates and describes shovels, dredges, and special unloaders. 3500 w. Engineering Magazine—May, 1908. No. 91952 B.

Ore Handling.

Methods of Handling Ore on the Great Lakes. Charles H. Wright. Brief illustrated descriptions of locomotive cranes operating a 2-rope grab bucket, electric side dump cars, and other devices for economical handling. 900 w. Min Wld—April 4, 1908. No. 91415.

MISCELLANY.

Aeronauutics.

See Gasoline Engines, under COMBUSTION MOTORS.

Air Resistance.

The Resistance of the Air and Mr. Eiffel's experiments. Describes the methods and apparatus adopted in these investigations, outlining the results obtained. 4500 w. Engr, Lond—April 17, 1908. No. 91981 A.

Sugar Machinery.

A Large Formosan Sugar Factory. Illustrates and describes the modern machinery built for a large, fully-equipped factory on the island of Formosa, belonging to the Japanese. 3000 w. Engr, Lond—March 27, 1908. No. 91465 A.

Textile Machinery.

Safety Appliances on Looms in Cotton Mills. Illustrated descriptions of causes of accidents and means for preventing them. 2500 w. Engng—April 17, 1908. No. 91977 A.

We supply copies of these articles. See page 495.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Prevention of Accidents in and Around Mines. H. O. Prytherck. Read at Y. M. C. A. Mining Inst., Scranton, Pa. Precautions recommended for anthracite mines. 1800 w. Mines & Min—April, 1908. No. 91320 C.

Australia.

Coalfields and Collieries of Australia. F. Danvers Power. Information in regard to the deposits, the quantity, quality, fossils, etc. 2500 w. Aust Min Stand—Feb. 19, 1908. Serial. 1st part. No. 91258 A.

Briquetting.

See Washing, under COAL AND COKE.

Classification.

A Practical Classification for Low-Grade Coals. Marius R. Campbell. Explains the essential points of a proposed classification. 2500 w. Ec-Geol—March, 1908. No. 91754 D.

Classification of Coals by the Split Volatile Ratio. D. B. Dowling. Brief discussion of methods of classification that have been used, with diagrams for comparison. 1500 w. Can Min Jour—April 15, 1908. No. 91794 C.

Coal Cutting.

An Electric Coal Puncher. Timothy W. Sprague. An illustrated description of the construction and method of operation of this coal-cutting machine. 2800 w. Mines & Min—April, 1908. No. 91319 C.

Coke Drawing.

The Hebb Coke Drawing Machines. Illustrated description. 900 w. Ir Age—April 23, 1908. No. 91884.

Coking.

The Manufacture of Metallurgical Coke. M Hennebutte. Trans. from the French. Explains the principles and methods of manufacture. 1800 w. Queens Gov Min Jour—March 14, 1908. No. 91686 B.

See also Washing, under COAL AND COKE.

Coking By-Products.

Disposal of Coal Tar—Carroll Miller. Read before the New England Assn. of Gas Engrs. On the value of tar as a by-product to both the gas and coke industries. Discussion. 5000 w. Pro Age—April 15, 1908. No. 91691.

Culm.

The Recovery of Anthracite from Culm Banks. Richard Lee. Illustrated account of recovery from culm by washing, the cost, methods, etc. 2000 w. Eng & Min Jour—April 4, 1908. No. 91433.

Electric Power.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnie en Belgique). Alfred Lambotte. The second part of the serial describes the installations of the Grand-Hornu collieries and the electric pumping plant at the Baudour colliery. Ills. 13000 w. Soc Belge d'Elécns—March, 1908. No. 91507 E.

England.

The Littleton Collieries. From the *Jour.* of the British Federated Soc. of Min. Students. Gives an outline of the interesting history of these collieries, with description of the mines and methods. 3500 w. Ir & Coal Trds Rev—March 27, 1908. No. 91469 A.

See also Eight-Hour Day, under INDUSTRIAL ECONOMY.

Explosions.

The Prevention of Coal Mine Explosions. W. B. Williams. Several methods are suggested. 1500 w. Eng & Min Jour—April 18, 1908. No. 91791.

Caught in a Coal Mine Explosion. R. M. Downie. An account of the experience. 1500 w. Eng & Min Jour—April 11, 1908. No. 91644.

Remarks on Some Recent Explosions in Coal Mines. C. J. Coll. Address before the Min. Soc. of Nova Scotia. Deals principally with methods of prevention. 4000 w. Can Min Jour—April 15, 1908. No. 91795 C

Explosives.

The Evolution of the Coal Mine Explosive. E. J. Deason. Information concerning the permitted list in England. 1800 w. Ir & Coal Trds Rev—April 17, 1908. No. 91986 A.

Mine Fires.

The Causes of, and Protection against, Mine Fires in the North West Bohemian Lignite District (Ursachen und Bekämpfung von Grubenfeuern im nordwestböhmischen Braunkohlenrevier). Wolfgang Kummer. Illustrates and describes the arrangements for fire protection. 3000 w. Oest Wochenschr f d Oeff Baudienst—March 21, 1908. No. 91585 D.

Mining.

The Systematic Development of a Coal Mine. William Leckie. Illustrated description of work at Pocahontas, Va., and vicinity. 3500 w. Eng & Min Jour—April 25, 1908. No. 91940.

Submarine Coal Mining. John Johnston. Read before the Min. Soc. of Nova Scotia. Deals with the subject generally. 1200 w. Can Min Jour—April 15, 1908. No. 91792 C.

We supply copies of these articles. See page 495.

See also Coal Cutting, under COAL AND COKE; and Cages, and Car Loaders, under MINING.

Mining Plants.

The Plants of Pits Heinrich and Robert of the de Wendel Colliery, Herringen (Die Schachtanlage Heinrich & Robert des Steinkohlenbergwerks "de Wendel" in Herringen bei Hamm. i. Westf.). A. Hochstrate. Illustrated description of the electric installations and mining plants. 3000 w. Serial. 1st part. Elek Kraft u Bahnen—Jan. 4, 1908. No. 91552 D.

Mississippi.

The Lignite of Mississippi. Calvin S. Brown. Describes these deposits, giving information and analyses. 1200 w. Ec-Geol—April, 1908. No. 91842 D.

Montana.

The Coal and Lignite Deposits of Montana. Jesse Perry Howe. Describes the deposits and methods of working. Ills. 3500 w. Min Wld—April 25, 1908. Serial. 1st part. No. 91943.

Southern Extension of the Kootenai and Montana Coal-Bearing Formations in Northern Montana. Cassius A. Fisher. Gives results of recent investigations, describing the formations. 6000 w. Ec Geol—Jan., 1908. No. 91306 D.

Ohio.

The Pomeroy Coal in Ohio. J. A. Bownocker and D. D. Condit. Aims to show that this coal seam is the equivalent of the Redstone coal of Pennsylvania and West Virginia. 3000 w. Ec-Geol—April, 1908. No. 91841 D.

Pennsylvania.

Distribution of Phosphorus in the Pittsburg Coal Seam. J. R. Campbell. Gives a comparison of analyses of top, bottom and other parts of the seam in different mines. 2000 w. Mines & Min—April, 1908. No. 91315 C.

Phosphorus.

See Pennsylvania, under COAL AND COKE.

Rescue Appliances.

Rescue Work in Collieries. An illustrated account of the opening of the new station of the Lancashire and Cheshire coalowners, the training and apparatus. Editorial. 9500 w. Col Guard—April 10, 1908. No. 91816 A.

Liquid Air and Its Practical Applications (Ueber flüssige Luft und deren praktische Verwendung). Otto Suess. The first part of the serial deals with apparatus for the liquefaction of air, the second with its use in rescue apparatus. Ills. 2500 w. Serial. 2 parts. Oest Zeitschr f. Berg- u Huttenwesen—March 7 and 14, 1908. No 91543 each D.

Sampling.

Moisture in Coal. E. E. Somermeier, in *Jour. Am. Chem. Soc.* On the importance of proper care of samples for analysis to prevent moisture changes. 3000 w. Mines & Min—April, 1908. No. 91354 C.

Washing.

Coal Washing. C. C. Myers. Brief consideration of this process of separation and the defects of the washers now in use. 1200 w. Sib Jour of Engng—April, 1908. No. 91908 C.

Washing of Bituminous Coal for Coking Purposes. Randolph Bolling. Historical account of its introduction into the United States, and of the methods of testing coal to determine its adaptability to the process. Ills. 2200 w. Min Sci—April 16, 1908. No. 91798.

Coal Screening, Washing, and Briquette-Making Plant at the Alstaden Collieries, Germany. Illustrated description. 2000 w. Ir & Coal Trds Rev—April 3, 1908. No. 91679 A.

Coal Washing as Practiced by the Nova Scotia Steel and Coal Company, at Sydney Mines, Cape Breton, N. S. C. L. Cantley. Gives an outline of the process, with analyses of the washed coal. 3500 w. Can Soc of Civ Engrs—April 2, 1908. No. 91775 N.

Washing and Coking Tests of Coal and Cupola Tests of Coke Conducted by the United States Fuel-Testing Plant at St. Louis, Mo., Jan. 1, 1905, to June 30, 1907. Richard Moldenke, A. W. Belden, and G. R. Delamater. 15400 w. U S Geol Survey—Bul. 336. No. 91706 N.

See also Culm, under COAL AND COKE.

COPPER.

Blast Furnaces.

The Cananea Blast Furnace. Charles F. Shelby. Full details and drawings of a copper blast furnace. 3000 w. Eng & Min Jour—April 25, 1908. No. 91936.

The Corrosion of Water-Jackets of Copper Blast-Furnaces. George B. Lee. Brief note introducing a discussion. 3000 w. Bul Am Inst of Min Engrs—March, 1908. No 91712 C.

California.

Primary Chalcocite in California. Oscar H. Hershey. An account of an unusual type of copper deposit containing chalcocite as a primary mineral. Not of economic importance, but interesting. 1200 w. Min & Sci Pr—March 28, 1908. No. 91359.

Chalcocite.

See California, under COPPER.

Congo.

The Copper and Tin Deposits of Katanga. John R. Farrell. An illustrated article giving information regarding deposits of iron, copper, and tin, which are

being developed. The copper belt is the most important. 4000 w. Eng & Min Jour—April 11, 1908. No. 91640.

Costs.

Cost of Lake Superior and Montana Copper. James Ralph Finlay. A review of results and costs of mining and smelting, showing favorable conditions in Michigan and high costs at the Butte mines. 5000 w. Eng & Min Jour—April 25, 1908. No. 91938.

Mexico.

Cananea Consolidated Copper Company. Abstract from a recent report of the Greene Consolidated Copper Co., concerning developments in 1907. 2000 w. Eng & Min Jour—April 11, 1908. No. 91641.

Peru.

Recent Developments at Cerro de Pasco, Peru. J. C. Pickering. Reviews the history of this district, first mined for silver and later for copper, the character of the deposits and the development. Ills. 2500 w. Eng & Min Jour—April 11, 1908. No. 91642.

Queensland.

Great Fitzroy Copper and Gold Mine, Mount Chalmers. B. Dunsten. Maps, illustrations, with description, and account of mining developments. 7000 w. Queens Gov Min Jour—March 14, 1908. Serial. 1st part. No. 91687 B.

Refineries.

See Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Rhodesia.

Kansanshi Mine and Mine Sampling. J. R. Farrell. Information concerning an ancient copper mine in northwestern Rhodesia. Ills. 2200 w. Min & Sci Pr—April 18, 1908. No. 91899.

Smelter Hygiene.

Welfare of Laborers in Reduction Works. L. S. Austen. Discusses what has, and can be done. 3800 w. Min & Sci Pr—April 11, 1908. No. 91758.

Smelters.

The New Balaklala Smelter of the Balaklala Consolidated Copper Co., at Coram, Cal. J. L. Mauch. Illustrates and describes the proposed sampling and smelting operations. Also editorial. 8000 w. Mines & Min—April, 1908. No. 91317 C.

Smelting.

See Costs, under COPPER.

Utah.

See Copper, under ORE DRESSING AND CONCENTRATION.

GOLD AND SILVER.

Assaying.

Assay of Battery Chips and Screens. Leslie J. Wilmoth. Reports results of experiments made by the author. 2200 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1908. No. 91470 E.

The Indian Mint Assay of Silver Bullion. F. T. C. Hughes. Remarks on the bullion and method of sampling, with a detailed description of the method employed in assaying silver at the Indian Mints. Ills. 3000 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91864 N.

The Sulphuric Acid Process for Parting Gold and Silver. A description of the methods used at the U. S. Government Assay Office, in New York City, with information, relating to the business carried on. Ills. 3000 w. Brass Wld—April, 1908. No. 91768.

Australia.

"Mt. Morgan" Mine. A talk by G. M. Colvocoresses to the senior class of Met. & Min. Engrs. at Sheffield Scientific School, concerning this mine in Australia. 4500 w. Yale Sci M—April, 1908. No. 91623 C.

See also Gold Milling, under ORE DRESSING AND CONCENTRATION.

Chile.

The Silver-Bearing Veins of Huantajaya, Tarapaca, Chile. Jose Muro. Abstract translation describing these deposits. 1300 w. Min Jour—April 18, 1908. Serial. 1st part. No. 91976 A.

Cobalt.

See Silver Milling, under ORE DRESSING AND CONCENTRATION.

Columbia.

Gold Deposits of Sierra Nevada de Santa Marta. Francis C. Nicholas. Information in regard to the gold deposits of Colombia, S. A. 2200 w. Min Wld—April 18, 1908. No. 91801.

Cyaniding.

Electro-Cyanide Processes. Douglas Lay. A discussion of claims regarding these processes. 2000 w. Eng & Min Jour—April 11, 1908. No. 91643.

Development of the Cyanide Process for Silver Ores in Mexico. Bernard Macdonald. Explains why cyanidation has been adopted, and pan-amalgamation abandoned. 1700 w. Eng & Min Jour—April 18, 1908. No. 91785.

Present Cyanide Practice in Mexico. Mark R. Lamb. Fine grinding, filtering of the slime, and air agitation are in use in the treatment of silver ores. Ills. 5800 w. Eng & Min Jour—April 4, 1908. No. 91430.

Cyanidation of Silver Ores at Guanajuato. Bernard Macdonald. Only stamps are used for crushing, long treatment of pulp, percolation, decantation, and precipitation. 7000 w. Eng & Min Jour—April 4, 1908. No. 91431.

Cyaniding Cripple Creek Ores. F. L.

Barker. Discusses the cost of treatment in mills, rates of freight, analyses of ores; and describes the Isabella and the Wild Horse mills. 3000 w. Mines & Min—April, 1908. Serial. 1st part. No. 91318 C.

See also Silver Milling, and Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Germany.

See same title, under LEAD AND ZINC.

Hungary.

See Placers, under GOLD AND SILVER.

Mexico.

Stories of the Batopilas Mines, Chihuahua. Mark R. Lamb. An account of peculiar deposits where sampling was hardly an indication of value, with information of interest. Ills. 1200 w. Eng & Min Jour—April 4, 1908. No. 91426.

See also Silver Milling, under ORE DRESSING AND CONCENTRATION.

Nevada.

Rawhide, Nevada. Algernon Del Mar. An account of the discovery and development of this gold camp. Ills. 1000 w. Eng & Min Jour—April 25, 1908. No. 91937.

See also Placers, under GOLD AND SILVER.

North Carolina.

Ore-Deposits of the Eastern Gold-Belt of North Carolina. W. O. Crosby. Information in regard to the location, geology, deposits, and conditions of this district. 3000 w. Bul Am Inst of Min Engrs—March, 1908. No. 91711 C.

Nova Scotia.

A Practical Suggestion for the Testing of the Gold Mines of Nova Scotia. Fred. P. Ronnan. Read before the Min. Soc. of Nova Scotia. Outlines a plan for improving this industry in Nova Scotia. 2000 w. Can Min Jour—April 15, 1908. No. 91793 C.

Placers.

The Gold Alluvials of the River Drau in Hungary. A. von Gernet. Brief note concerning these gold-bearing gravels. 400 w. Inst of Min & Met, Bul. 43—April 2, 1908. No. 91869 N.

A Tertiary River Channel Near Carson City, Nevada. John A. Reid. Illustrated description of a large and well defined channel on the east slope of the Sierra Nevada Mts., giving such facts about it as appertain to the mining industry. 2500 w. Min & Sci Pr—April 18, 1908. No. 91898.

Rand.

See Electric Power, under MINING.

Rhodesia.

A Short Account of the Penhalonga Mine. H. P. Townsend. Describes the location, the geological, and mineralogical characteristics, and the methods of mining and milling at this gold and silver mine in Rhodesia. Discussion. 5000 w. Jour S African Assn of Engrs—Feb., 1908. No. 91259 F.

IRON AND STEEL.

Armor Plate.

Armor Plate Forging and Machining at the Bethlehem Steel Works. A non-technical illustrated description. 1600 w. Mach, N Y—April, 1908. No. 91322 C.

Assaying.

The Determination of Nickel in Nickel Steel (Die Bestimmung des Nickels in Nickelstahl). O. Brunck. A discussion of prevailing methods with conclusions drawn from investigations. 1600 w. Stahl u Eisen—March 4, 1908. No. 91538 D.

Blast Furnace Gas.

The Cleaning of Blast-Furnace Gas (Epuration des Gaz de Hauts-Fourneaux). V. Defays-Lanser. A discussion of the problem and of attempts to solve it, and a description of the Sépulchre system. Ills. 4000 w. Rev de Métal—March, 1908. No. 91514 E + F.

Blast Furnaces.

The New Blast Furnace of the Hamilton Steel and Iron Company, Ltd. Illustrated description of this Canadian plant. 1500 w. Ir Age—April 9, 1908. No. 91484.

The New Iron Works of the Staveley Company. Illustrated detailed description of new blast furnaces and accessories recently added to these works. Plate. 4000 w. Engng—March 27, 1908. Serial. 1st part. No. 91461 A.

The Blast Furnace Diagram (Das Hochofendiagramm). Carl Brisker. Gives a series of curves showing the theoretical operations and reactions in the blast furnace. 3500 w. Stahl u Eisen—March 18, 1908. No. 91541 D.

Blowing Engines.

A Blowing-Engine Repair. Alonzo G. Collins. Describes the conditions and the methods used. 1200 w. Power—April 14, 1908. No. 91694.

Briquetting.

The Briquetting of Iron Ores (Das Brikettieren von Eisenerzen). A summary of the findings of a commission of the German Steel Makers' Association on the present status and possibilities of the process. Ills. 3000 w. Stahl u Eisen—March 4, 1908. No. 91536 D.

Cuba.

Iron Mining in Cuba. An illustrated description of the old and new properties of the Spanish American Iron Company, the methods of mining, etc. 8000 w. Ir Age—April 9, 1908. No. 91483.

Electro-Metallurgy.

Possibilities in the Electric Smelting of Iron Ores. Alfred Stansfield. Read before the Can. Min. Inst. Discusses what can probably be accomplished, the manner of obtaining successful results, and the advantages and drawbacks of the electrical process. 3000 w. Can Min Jour—April 1, 1908. No. 91417.

The Electro-Metallurgy of Iron (L'Electrosidérurgie). Charles Le Chatelier. Discusses the production of steel in the electric furnace. Ills. 8000 w. Rev de Métal—March, 1908. No. 91512 E + F.

Ferro-Alloys.

A New Method of Producing Ferro-Alloys Free from Carbon (Neuer Weg zur Herstellung kohlenstoffarmer Ferrolegierungen). B. Neumann. Describes the results of a series of laboratory experiments. Ills. 2500 w. Stahl u Eisen—March 11, 1908. No. 91539 D.

Japan.

Japan's Manufacture and Importation of Iron Goods. M. Kawara. Gives a brief historical sketch of Japan's home manufacture and foreign importation, discussing the present situation and the outlook. 2500 w. Engineering Magazine—May, 1908. No. 91947 B.

New York.

The Magnetite Belts of Putnam County, N. Y. C. A. Stewart. Gives a description of the wall rocks of closely associated deposits, stating facts that may prove a value in the future. 3500 w. Sch of Mines Qr—April, 1908. No. 91914 D.

Nomenclature.

The Uniform Nomenclature of Iron and Steel. Republished report of Committee of the International Assn. for Testing Materials at the Brussels Congress, 1906. 3300 w. Bul Am Inst of Min Engrs—March, 1908. No. 91716 C.

Ontario.

The Moose Mountain Iron Range, Ontario. J. J. Bell. Illustration, with short description. 600 w. Eng & Min Jour—April 18, 1908. No. 91786.

Open Hearth.

See Steel Works, under IRON AND STEEL.

Rolling Mills.

See Steel Works, under IRON AND STEEL.

Russia.

The Bogoslovsk Mining Estate. William H. Shockley. Description of this property, its management, conditions, labor, transportation, etc. The chief industry of the estate is iron-making in charcoal blast-furnaces, and the manufacture of steel; gold, copper, and other minerals are found. Ills. 9500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91715 C.

Segregation.

Segregation in Steel Ingots. Henry M. Howe. Brief notes on investigations made to determine the laws which govern segregation, and the influences that affect it. 1200 w. Sch of Mines Qr—April, 1908. No. 91911 D.

Steel Making.

Electrical Machinery in Steel Making. W. T. Dean. Read before the Schnectady Sec. of the A. I. E. E. An outline of the mechanical processes and means of transportation. Ills. 2500 w. Sci Am Sup—April 11, 1908. No. 91610.

See also Steel, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Steel Works.

The Works of Sir William Arrol and Co., Limited. Illustrated description of the Dalmarnock structural-steel works, at Glasgow, and the methods employed. Plates. 4500 w. Engng—March 20, 1908. No. 91274 A.

The Plant of the Andrews Steel Co., at Newport, Ky. Illustrated detailed description of the open-hearth and rolling-mill equipment of a recently completed plant which is well arranged. 3500 w. Ir Trd Rev—April 2, 1908. No. 91341.

See also Armor Plate, under IRON AND STEEL.

Sweden.

The History of Iron Making in Sweden (Zur Geschichte des schwedischen Hüttenwesens). Paul Martell. Reviews progress since 1770. 6000 w. Oest Zeitschr f Berg- u Hüttenwesen—March 28, 1908. No. 91544 D.

LEAD AND ZINC.

Germany.

The Ems Silver-Lead Mines with Special Reference to Recent Improvements (Das Emser Blei- und Silberwerk, unter besonderer Berücksichtigung der in den letzen Jahren geschaffenen Neuanlagen). Hans Linkenbach. Describes the deposits, mining methods, ore dressing and smelting practice, etc. Ills. 3000 w. Serial. 1st part. Glückauf—March 14, 1908. No. 91546 D.

Roasting.

Wilfley Roasting Process. J. M. McClave. Describes a new method of roasting sulphide ores to prepare them for magnetic concentration. Ills. 1000 w. Mines & Min—April, 1908. No. 91314 C.

Zinc Assaying.

Sampling and Assaying Spelter. Evans W. Buskett. Gives methods of assaying for iron, lead, and cadmium. 1200 w. Eng & Min Jour—April 18, 1908. No. 91789.

MINOR MINERALS.

Arsenic.

A Rapid Method for the Estimation of

We supply copies of these articles. See page 495.

Arsenic in Ores. Harley E. Hooper. Explains a method suitable for sulphide or oxidized ores containing upwards of 1% of arsenic. 700 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91863 N.

Cement.

Geology of the Cement Belt, in Lehigh and Northampton Counties, Pa., with Brief History of the Origin and Growth of the Industry and a Description of the Methods of Manufacture. Frederick B. Peck. Map & Ills. 10500 w. Ec-Geol—Jan., 1908. No. 91305 D.

Inland Portland Cement Works. An illustrated description of the "Saxon" and the "Norman" works and the processes used. 4000 w. Engr, Lond—March 20, 1908. No. 91281 A.

The Revolving Furnace in the Cement Industry (Il Forno rotativo nell Industria del Cemento). From *Baumaterialienkunde.* An elaborate discussion, both theoretical and practical. 5500 w. Serial. 1st part. Il Cemento—Feb., 1908. No. 91533 D.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANMISSION.

Diamonds.

The Geology of Diamonds. Describes the deposits in alluvial gravels and in pipes, discussing theories in regard to the original formation in pipes. 2000 w. Mines & Min—April, 1908. No. 91316 C.

Diamonds in Arkansas. George F. Kunz, and Henry S. Washington. Information regarding the geology, general conditions, and occurrence. 3500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91713 C.

The Conversion of Diamond Into Coke in High Vacuum by Cathode Rays. Charles A. Parsons, and Alan A. Campbell Swinton. Read before the Roy. Soc. Brief account of experimental investigations. 700 w. Elec Engr, Lond—April 3, 1908. No. 91665 A.

Kaolin.

The Kaolins of the Dry Branch Region, Georgia. Otto Veatch. The geology and structure of these clay deposits are described, giving a theory of their origin. 2500 w. Ec-Geol—March, 1908. No. 91753 D.

Oil.

Prospecting in the Oil Fields of Eastern Colorado. Arthur Lakes. Gives experiences in both surface and deep boring examinations, with conclusions and recommendations. 2000 w. Min Sci—April 23, 1908. No. 91944.

Potash.

The Economical Production and Utilization of Steam and Power in Potash Mining (Wirtschaftliche Erzeugung und Ausnutzung von Dampf und Kraft im Kalibergbau). R. Scharf. A general discussion of economy in power production in mining. Ills. 4900 w. Serial. 1st part. March 28, 1908. No. 91548 D.

Tar Sands.

The Tar Sands of the Athabasco River, Canada. Robert Bell. Describes these deposits, discussing the origin of the tar, and the value and usefulness of the material. 4500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91710 C.

Tin.

See Congo, under COPPER.

MINING.

Accidents.

The Shaft Accidents at Foggs, Barrow and Rawdon Collieries. From report by Prof. R. A. S. Redmayne on the causes of, and circumstances attending these accidents. Ills. 10000 w. Ir & Coal Trds Rev—April 10, 1908. No. 91817 A.

Cages.

The Design of Cages for Modern Collieries. J. S. Barnes. Considers some of the factors that determine the size of a cage, and gives sections, elevations and descriptions of designs. 2800 w. Ir & Coal Trds Rev—April 3, 1908. Serial. 1st part. No. 91678 A.

See also Hoisting, under MINING.

Car Loaders.

A Mechanical Substitute for the Shovel in Coal Mines. W. E. Hamilton. Illustrated description of the Hamilton loading machine and its operation. 2500 w. Eng & Min Jour—April 18, 1908. No. 91790.

Compressed Air.

Design of Compressed Air Plants. E. A. Rix. Read before the Mining Assn. Gives data used by the writer in making the necessary calculations, and presents a problem showing the application. 3500 w. Cal Jour of Tech—Feb., 1908. No. 91301.

Joints and Fittings for High-Pressure Air. H. V. Haight and B. C. Batcheller. Describes and illustrates fittings used in connection with pneumatic haulage plants and other applications in mining. 5800 w. Am Mach—Vol. 31, No. 17. No. 91871.

Costs.

The Cost of Mining—General Conditions. James Ralph Finlay. The present article discusses the factors that determine variations in cost. 7500 w. Eng & Min Jour—April 18, 1908. Serial. 1st part. No. 91784.

Variations in Mining Costs. John B. Hastings. Reviews an article by J. R. Finlay, published Jan. 4, 1908, and gives estimates made by the writer, and a discussion of the subject generally. 3000 w. Min & Sci Pr—March 28, 1908. No. 91358.

See also same title, under COPPER.

Diving.

Diving: With Special Reference to Mines. J. S. Haldane. Abstract of a paper read at meeting of the N. Staffordshire Inst. of Min. & Mech. Engrs. Deals with the physiological side of the subject, with special reference to diving work in mines. Discussion. 6000 w. Ir & Coal Trds Rev—April 10, 1908. No. 91824 A.

Diving in Mining Operations (Ueber Taucherei im Bergwerksbetriebe). Herr Grahn. Discusses diving apparatus and the ways in which divers may be employed in mining. Ills. 3000 w. Glückauf—Mar. 7, 1908. No. 91545 D.

Drilling.

Air Drill Practice in the Joplin District. Otto Ruhl. Describes the practice and use of power drills. 1500 w. Min Sci—April 9, 1908. No. 91682.

Electric Hoisting.

Electrically-Driven Winding-Gear, and the Supply of Power to Mines. Arthur Henry Preece. Considers the cost and discusses certain aspects of the question. Ills. 6800 w. Inst of Civ Engrs, No. 3698—March 26, 1907. No. 91850 N.

See also Electric Power, under MINING.

Electric Power.

The Application of Hydro-Electric Power to Slate-Mining. Moses Kellow. Illustrated detailed description of a plant installed in North Wales. 7000 w. Inst of Civ Engrs, No. 3650—March 26, 1907. No. 91849 N.

Discussion on Hydro-Electric Power and on Electrical Winding. Discusses papers Nos. 3650 and 3698, by Kellow, and Preece. 13500 w. Inst of Civ Engrs—March 26, 1907. No. 91851 N.

The Electrical Equipment of Gold Mines. H. J. S. Heather. General remarks on the choice of voltage and system and matters relating to cost, with suggestions as to choice of machinery and methods of transmission, distribution, etc. 5000 w. Inst of Min & Met, Bul 43—April 2, 1908. No. 91866 N.

On the Cost of Power at Mines of the Witwatersrand, with Reference to a Proposed Supply from a Central Source. Henry James Shedlock Heather, and Anthony Maurice Robeson. A report of an investigation carried out with reference to the cost of a proposed electrical supply. 8000 w. Inst of Civ Engrs, No. 3711—1907. No. 91844 N.

See also Electric Hoisting, under MINING; and Electric Power, and Mining Plants, under COAL AND COKE.

Geology.

Dip and Pitch. R. W. Raymond. Note on the meaning of these terms when applied to ore-deposits. 600 w. Bul Am Inst of Min Engrs—March, 1908. No. 91714 C.

Haulage.

Inclined Planes and Mine Tracks (Plans Inclinés et Voies Minières). A. Laran. Describes an arrangement for double-track slope haulage and switches for mine railways. Ills. 2000 w. Mem Soc Ing Civ de France—Jan., 1908. No. 91503 G.

A Simple Optical Signal Device for Rope and Chain Haulage Ways Driven by Three-Phase Motors (Eine einfache optische Signalvorichtung für Seil- und Kettenbahnen mit Drehstromantrieb). Hans Neubauer. Illustrates and describes an arrangement of signal lights by which the operation of the motor can be controlled. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—Mar. 7, 1908. No. 91542 D.

Hoisting.

Skips and Cages. S. A. Worcester. A comparison of the important features of these two devices in practical operation for the hoisting of ores. 1500 w. Min & Sci Pr—April 11, 1908. No. 91757.

Locomotives.

Accumulator Locomotives for Mines. Illustrates and describes locomotives of special type, having a large capacity in proportion to their weight. 1000 w. Iron & Coal Trds Rev—March 20, 1908. No. 91282 A.

Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Pumping.

An Emergency Pumping Plant at Cannock Chase Colliery. S. F. Sopwith. Read before the S. Staffordshire & Warwickshire Inst. of Min. Engrs. Explains the conditions, describing the pumping arrangements and results with an electric pump. 3500 w. Ir & Coal Trds Rev—April 17, 1908. No. 91985 A.

Quarrying.

See Electric Power, under MINING.

Reinforced Concrete.

The Utilization of Concrete in Mining Work. Ernest McCullough. Considers the method of constructing reinforced-concrete beams, and formulae for calculating compression and tensile stresses. Ills. 5000 w. Min Wld—April 11, 1908. No. 91683.

Sampling.

Sampling of Mine Dumps. Henry S. Munroe. On the advantages of sinking a vertical shaft through the dump to obtain the samples. Ills. 1500 w. Sch of Mines Qr—April, 1908. No. 91910 D.

See also Rhodesia, under COPPER.

Shaft Sinking.

Record Shaft Sinking on the Rand Gold Field. Ralph Stokes. Describes the remarkable performances at the Brakpan

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Mines, Ltd. Ills. 1500 w. Min Wld—April 18, 1908. No. 91802.

Stope Drawing.

A Method of Mining. C. Everard Arnold. Illustrated description of a method used at Smuggler, Colorado, for removing stope-filling. 9000 w. Min & Sci Pr—April 11, 1908. No. 91759.

Tunneling.

A Modern Type of Mine Tunneling Machine. Silas A. Knowles, and Walter E. Carr. Illustrated description of a reciprocating cutter head tunneling machine. 3000 w. Min Wld—April 18, 1908. No. 91800.

Tunnels.

Deep Mining Tunnels in Clear Creek County, Colorado. H. P. Dickinson. Brief illustrated account of some of the larger bores, their history and methods. 1000 w. Min Sci—April 16, 1908. No. 91797.

Valuation.

On Certain Errors in Computing Ore Values. Henry Abbott Knox. Errors due to the failure to take into account the more or less regular distribution of the ore in the plane of the vein to be estimated. 1000 w. Eng & Min Jour—April 18, 1908. No. 91787.

ORE DRESSING AND CONCENTRATION.

Centrifugal Classifiers.

The Centrifugal Classifier (Le Classeur Centrifuge). M. Baclé. A description of the Souchon dry concentrating device and its operation. Ills. 1700 w. Bul Soc d'Encour—Feb., 1908. No. 91518 G.

Copper.

The Utah Copper Mill Near Garfield, Utah. Robert B. Brinsmade. Illustrates and describes the mining of porphyry copper ores by steam-shovel, and concentration in a 6,000-ton mill. 3500 w. Min Wld—April 4, 1908. No. 91414.

The Boston Consolidated Concentrator, Utah. Robert B. Brinsmade. Illustrated detailed description of buildings and equipment for concentrating low-grade sulphide ore. The cost of refined copper is 8.5 cents per pound. 3500 w. Min Wld—April 18, 1908. No. 91799.

Crushing.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Elmore Process.

See Ore Dressing, under ORE DRESSING AND CONCENTRATION.

Gold Milling.

Description of the Montana-Tonopah Company's Mill. Traces the ore from the mine through the crusher, and various processes of milling. 1500 w. Can Min Jour—April 1, 1908. No. 91418.

Westralian Wet-Crushing Plants, with Some Notes on Labor Efficiency. Gerard W. Williams. Describes the methods in use in West Australian goldfields, discussing the value of efficient labor. 6000 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1908. No. 91471 E.

See also Cyaniding, under GOLD AND SILVER.

Magnetic Separation.

Magnetic Separation of Ores in Joplin District. Doss Brittain. Describes the roasting kiln and magnetic separators. Ills. 800 w. Min Wld—April 25, 1908. No. 91942.

An Electro-Magnet for Testing the Suitability of an Ore for Magnetic Separation. L. H. L. Huddart. Illustrated description. 700 w. Inst of Min & Met, Bul. 43—April 2, 1908. No. 91868 N.

See also Roasting, under LEAD AND ZINC.

Mixed Sulphides.

Separation of Mixed Sulphides at Charcas, San Luis Potosi. R. C. Canby. Illustrated description of a plant for the treatment of highly zinkiferous copper-lead ores. Sutton-Steele concentrating tables are used. 1500 w. Eng & Min Jour—April 4, 1908. No. 91428.

Ore Dressing.

Ore Dressing with Special Reference to Oil Concentration. A review of the present status of the art of ore dressing given by W. G Swart in his presidential address before the W. Assn. of Tech, Chem. & Mets., with notes on acid flotation and the new Elmore oil vacuum process. Also description of a dry concentrating table and a new separator. 5000 w. Elec-Chem & Met Ind—May, 1908. No. 91961 C.

Silver Milling.

Concentrating Cobalt Ores. G. H. Gillespie. Suggests a method of milling and concentration for these complex argentiferous ores. 3000 w. Can Min Jour—April 1, 1908. No. 91416.

Milling and Cyaniding Methods in Mexican Camp. Mark R. Lamb. Illustrates and describes model mills, their equipment and methods. 2500 w. Min Wld—April 11, 1908. No. 91684.

See also Cyaniding, under GOLD AND SILVER.

Slimes Treatment.

A Method of Settling Slimes as Applied to Their Separation from Solution in Cyanide Treatment. Horace G. Nichols. Describes a method which has given remarkable results both in the completeness of the separation effected and in the small proportion of liquid carried off. Ills. 2000 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91862 N.

Discussion on "A Method of Settling Slimes, as Applied to Their Separation

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from Solution in Cyanide Treatment." Horace G. Nichols' paper is discussed. 3500 w. Inst of Min & Met, Bul. 42—March 12, 1908. No. 91865 N.

MISCELLANY.

Alloys.

The Thermal Analysis of Alloys. C. L. A. Schmidt and W. K. Watkins. Shows how cooling curves may be used in determining the composition of alloys without chemical analysis. 3000 w. Cal Jour of Tech—April, 1908. No. 91966.

The Alloys of Gold and Tellurium. T. K. Rose. Describes examinations made and gives results and conclusions. 1200 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91861 N.

The Alloys of Silver (Les Alliages d' Argent). A. Portevin. Reviews recent literature on the alloys of silver with aluminium, bismuth, tin, antimony, etc., published in the *Zeitschrift für anorganische Chemie*. Ills. 5000 w. Rev de Métal—Mar., 1908. No. 91516 E + F.

The Alloys of Nickel and Bismuth (Les Alliages de Nickel et de Bismuth). A. Portevin. Gives the results of an investigation of their heat treatment and their metallography. Ills. 3500 w. Rev de Métal—Mar., 1908. No. 91513 E + F.

Australia.

The Mineral Resources of Western Australia. Hon. C. H. Rason. An interesting account of the development of the Australian goldfields, and other information. Discussion. 9000 w. Jour Soc of Arts—April 3, 1908. No. 91653 A.

Carat.

The Carat Weight. E. J. Vallentine. Information concerning the use of this measure, and the steps in progress to cause the adoption of a metric carat as a standard. 1200 w. Inst of Min & Met, Bul. 43—April 2, 1908. No. 91867 N.

China.

Mineral Resources of China. Bailey Willis. An interesting review of China, the development of its mineral resources, the deposits, the different fields, etc. 11700 w. Ec Geol—Jan., 1908. Serial. 1st part. No. 91304 D.

Mexico.

Empire Building in Western Mexico. Percy E. Barbour. An illustrated account of old mineral lands to be opened by new railroads. 3000 w. Eng & Min Jour—April 4, 1908. No. 91427.

Growth and Decay of the Mexican Plateau. Robert T. Hill. An illustrated article describing the geologic features and changes. 6000 w. Eng & Min Jour—April 4, 1908. No. 91425.

Character and Habits of the Mexican Miner. Allen H. Rogers. Describes the peculiarities of this class of laborers, and their value as miners. 3500 w. Eng & Min Jour—April 4, 1908. No. 91429.

Ore Deposits.

Artificial Vein Formation. R. C. Canby. Describes the occurrences of artificial vein formations in heap-roasted matte. 900 w. Eng & Min Jour—April 4, 1908. No. 91432.

The Localization of Values or Occurrence of Shoots in Metalliferous Deposits. J. D. Irving. Defines mining terms, and explains features of ore-deposits and their causes. 4500 w. Ec-Geol—March, 1908. No. 91755 D.

Queensland.

The Queensland Mining Industry. Report of the Under Secretary for Mines, reviewing the year 1907. 22000 w. Queens Gov Min Jour—March 14, 1908. No. 91685 B.

Salvador, C. A.

Mineral Resources of the Republic of Salvador, C. A. Santiago Ignacio Barbarena. An account of the fine results of the mining industry in recent years. 1000 w. Eng & Min Jour—April 18, 1908. No. 91788.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Signals.

Block Signals on the Railroads of the United States, Jan. 1, 1908. Tables issued by the Interstate Commerce Commission. 3500 w. R R Gaz—April 17, 1908. No. 91765.

New Automatic Block Signals on the Erie Railroad. Illustrated account of the system installed. The signals are of the electric motor semaphore type. 1600 w. R. R. Gaz—April 24, 1908. No. 91904.

Bolt Locking. W. H. Arkenburgh. Explains the use of bolt locks in an interlocking system, describing weak points in present practice, and the method of electrical bolt locking. 1800 w. R R Gaz—April 3, 1908. No. 91438.

Train Service.

A Long Continuous Run of 1876, and the Engine That Made It. C. H. Caruthers. An account of a 10-hour run from Jersey City to Pittsburgh, and description of engine. 1000 w. R R Gaz—April 10, 1908. No. 91619.

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MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Valve Cleaning and Repairs. Discusses right and wrong methods. 2000 w. Ry & Loc Engng—April, 1908. No. 91422 C.

Trials of the Vacuum Brake (Hardy System) on the Arlberg Lines. An illustrated description of the improved brake and report of trials made by the Austrian State Railway. 1700 w. Bul Int Ry Cong—March, 1908. No. 91622 G.

Tests of the Automatic, Quick Acting, Vacuum Brake for Freight Trains (Versuche mit der automatischen Vacuum-Güterzug-Schnellbremse). The results of elaborate tests carried out under the direction of the Austrian Minister of Railways. Ills. 10000 w. Serial. 1st part. Glasers Ann—Mar. 1, 1908. No. 91577 D.

Tests of Continuous Automatic Brakes on Freight Trains (Versuche mit durchgehenden selbsttätigen Bremsen bei Güterzügen). Johann Rihosek. Deals principally with the tests of the Vacuum brake in Austria. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—Mar. 6, 1908. No. 91580 D.

Car Lighting.

Car Lighting. Discussion of R. M. Dixon's paper on this subject. Ills. 5500 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91481.

Cars.

Passenger Rolling Stock; Natal Government Railways. Illustrated description of coaches built at the Durban workshops. 1500 w. Plate. Engng—March 20, 1908. Serial. 1st part. No. 91276 A.

Steel Car Construction and Maintenance. G. E. Carson. Calls attention to important points in their construction, with suggestions for repairs, and their cost. Discussion. Ills. 7500 w. Pro Ry Club of Pittsburgh—Feb. 28, 1908. No. 91859 C.

Electrification.

The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City. Discussion of William J. Wilgus' paper on this subject. 5000 w. Pro Am Soc of Civ Engrs—April, 1908. No. 91924 E.

Electrification of Steam Railroads and Terminals. Richard H. Phillips. Brief general discussion of the subject, especially in reference to St. Louis, with illustrated descriptions of types of motor cars, electric locomotives, etc., in use. 6500 w. Pro St Louis Ry Club—March 13, 1908. No. 91439.

The Preparation of the State Railways for the Introduction of Electric Operation on Trunk Lines (Die Vorbereitungen der Staatseisenbahnverwaltung für die Einführung des elektrischen Betriebes auf Hauptlinien). Wolfgang Heinrich von Ferstel. A discussion of applying electric traction on a large scale on the Austrian State Railways. Ills. 2500 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Mar. 27, 1908. No. 91583 D.

Locomotive Fuel Consumption.

Combustion Processes in English Locomotive Fire-Boxes. Dr. F. J. Brislee. A report of investigations. Ills. 6000 w. Inst of Mech Engrs—March 27, 1908. No. 91670 N.

Combustion and Heat Balances in Locomotives. Lawford H. Fry. Discusses the results of certain trials of locomotive engines, in so far as they deal with the processes of combustion and evaporation. Ills. 11500 w. Inst of Mech Engrs—March 27, 1908. No. 91671 N.

Locomotive Fuels.

Locomotive Fuel Economy. A study of the fuel question, giving government investigations and tests, discussing the mining, distribution, coaling stations, weighing coal, wastes, education of firemen, mechanical stokers, briquetting, etc. Ills. 30000 w. Am Engr & R R Jour—April, 1908. No. 91364 C.

Locomotive Management.

Some Instructive and Methodical Ideas as to the Handling of High Pressure Power by Enginemen so as to Render Satisfactory Service to Both the Mechanical and Transportation Departments. John A. Talty. Paper and discussion. 12000 w. Pro Cent Ry Club—March 13, 1908. No. 91836 C.

Locomotive Performance.

The Performance of a Four-Cylinder Locomotive. Charts and diagrams which show results with the exceptionally large engine designed by Dugald Drummond for the L. & S. W. Ry. 2200 w. Engr, Lond—April 10, 1908. No. 91822 A.

An Italian Unit of Locomotive Performance. Lawford H. Fry. An explanation of the use of the "virtual ton-kilometer" for recording work done by locomotives. 1200 w. R R Gaz—April 17, 1908. No. 91762.

Locomotives.

The 4-Cylinder Locomotive in America. An illustrated explanation of the 4-cylinder compound principle as applied on American railways. 1000 w. Mech Engr—April 17, 1908. No. 91973 A.

Tampa Northern Ten-Wheeler. Illustrated description of engines for either freight or passenger service. 9000 w. Ry & Loc Engng—April, 1908. No. 91421 C.

Heavy Pacific Type Locomotive, N. Y. C. & H. R. R. R. Illustrates and describes the heaviest passenger engines ever built

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for this road. 700 w. Ry & Engng Rev—April 4, 1908. No. 91413.

Ten-Wheel Locomotive for the Boston & Albany. Illustrated description of heavy engines of the 4-6-0 type. 500 w. Ry Age—April 10, 1908. No. 91688.

Shunting Locomotive, Great Central Railway. Illustrated description of this 8-wheel coupled 3-cylinder tank engine. 500 w. Engr, Lond—April 10, 1908. No. 91823 A.

New Tank Locomotives, North-Eastern Railway. Plate and description. 500 w. Engr, Lond—April 3, 1908. No. 91676 A.

The Last of a Famous Class. W. B. Paley. Information in regard to the "Lady of the Lake" class of express engines on the London & North Western. 2000 w. R R Gaz—April 17, 1908. No. 91766.

Recent Railway Developments. Illustrated description of 2-6-0 locomotives for working mixed and cargo trains on the Great Western Railway of Brazil. 1500 w. Prac Engr—April 10, 1908. No. 91807 A.

Locomotive Development in Germany. Illustrated description of a locomotive of the "Pacific" type for the Baden State Railways. 7000 w. Mech Engr—April 10, 1908. No. 91808 A.

Freight Tank Engine of the Prussian State Railroads with Schmidt Smoke-Tube Superheater. Illustrated detailed de-Railways. 700 w. Mech Engr—April 10, 1908. No. 91620.

The New Rolling Stock of the Italian State Railways (Le Nouveau Matériel roulant des Chemins de Fer de l'Etat Italien). P. Raulin. Illustrated description of several of the latest types of locomotives. 6500 w. Génie Civil—Mar. 21, 1908. No. 91531 D.

See also Train Service, under CONDUCTING TRANSPORTATION.

Locomotive Steam Pressures.

High Steam Pressures in Locomotive Service. Editorial review of the results of experiments by Prof. W. F. M. Goss. 3500 w. R R Gaz—April 3, 1908. No. 91434.

Motor Cars.

Petrol Rail Motor Inspection Car, North-Eastern Railway. Illustrated description. 600 w. Engr, Lond—April 3, 1908. No. 91677 A.

Shops.

A Modern Locomotive Works in Germany. Charles S. Lake. Historical review and brief illustrated description of German Locomotive Works recently built at Wildau, near Berlin. 2000 w. Mech Engr—April 3, 1908. No. 91662 A.

New Shops of Intercolonial Railway of Canada, Moncton, B. C. C. F. Bristol. Illustrated detailed description of an extensive application of reinforced concrete. 4500 w. Can Soc of Civ Engrs—April 16, 1908. No. 91894 N.

Tires.

The Source of Internal Tire Defects. An illustrated article, describing the experimental investigations made to determine the cause of the defects found. 1800 w. R R Gaz—April 24, 1908. No. 91906.

Wheels.

The Reason for the Steel Wheel. Editorial review of the development of car wheels in America, discussing the changes made necessary by conditions and the need of a cheaper reliable wheel for freight service. 1500 w. R R Gaz—April 10, 1908. No. 91617.

NEW PROJECTS.

Erie.

The New Four-Track Entrance of the Erie Railroad into Jersey City. Illustrates and describes work in progress through Bergen Hill which will give the Erie four tracks. 3500 w. Eng Rec—April 18, 1908. No. 91778.

PERMANENT WAY AND BUILDINGS.

Coaling Plants.

Notes on the Design and Performance of Locomotive Coaling and Ash-Handling Plants. Wilbur G. Hudson. Illustrated description of types, giving operating costs and general information. 4000 w. Eng News—April 16, 1908. No. 91737.

The Handling of Locomotive Coal and Ashes. C. F. Whitton. Deals with present practice and designs for coaling and ash-handling plants. Plans of stations, representing five methods are given, with operating cost of each. 5000 w. Can Soc of Civ Engrs—March 19, 1908. No. 91776 N.

Curves.

Re-Lining Long Curves by Running Trial Curves. R. W. Willis. An explanation of this method. 800 w. R R Gaz—April 3, 1908. No. 91437.

Compensation of Grades on Curves. Gives existing practice on important railways, and rules of Prof. Walter L. Webb, with criticisms by W. D. Taylor. 2500 w. Eng News—April 16, 1908. No. 91739.

Rails.

Steel Rails. T. S. Griffiths. Read before the Engrs.' Club, Toronto. Briefly considers the failures in rails and their possible causes. Also part of discussion following. 3500 w. Can Engr—April 3, 1908. No. 91377.

The New Rail Specifications of the Pennsylvania R. R. Gives new specifications drafted by the company's officials which were made public on April 11. 1500 w. Eng News—April 16, 1908. No. 91741.

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A Rail-Section Tracing-Machine. Horatio Edgar Dawson Walker. Explains the importance of renewals of worn and weakened rails, illustrating and describing a machine for ascertaining their condition. 2000 w. Inst of Civ Engrs, No. 3718—1907. No. 91855 N.

Reconstruction.

Some Recent Improvements on the Union Pacific Railroad. Illustrates and describes extensive reconstruction work, especially the Lane Cut-off. 4000 w. Eng Rec—April 4, 1908. No. 91381.

Reconstruction Work on Cincinnati, New Orleans, and Texas Pacific. Illustrates and describes numerous changes which will reduce the curvature and gradients, double-track a large part of the line, new viaducts, etc. 2500 w. Ry Age—April 24, 1908. Serial. 1st part. No. 91945.

Surveying.

Notes on the Natal-Cape Railway, Particularly with Regard to the Location and Setting-out. David Wilson. Describes the principal topographical features of the country, and the methods adopted in the final survey and setting-out of the line. Plate. 1800 w. Inst of Civ Engrs, No. 3662—1907. No. 91857 N.

Terminals.

Electrical Equipment of the Hoboken Terminal of the Lackawanna Railroad. Briefly describes the arrangement of this terminal and gives illustrated description of the very satisfactory illumination. 1600 w. Elec Wld—April 4, 1908. No. 91365.

Ties.

See Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Tracks.

The Railway Track of the Past, and Its Possible Development in the Future. J. W. Schaub. An illustrated discussion of the defects of tracks and the remedies. General discussion. 13500 w. Jour W Soc of Engrs—Feb., 1908. No. 91633 D.

Water Supply.

See Water Works, under CIVIL ENGINEERING, WATER SUPPLY.

Yards.

The Baltimore & Ohio's New Eastbound Freight Yard at Brunswick, Maryland. Plan and illustrated description of a large classification yard. 1500 w. R R Gaz—April 10, 1908. No. 91621.

TRAFFIC.

Demurrage.

Reciprocal Demurrage and Car Supply. Arthur Hale. Abstract of an address recently delivered to a committee of the Massachusetts legislature opposing a reciprocal demurrage bill. 7000 w. R R Gaz—April 10, 1908. No. 91618.

Freight Rates.

How the States Make Interstate Rates. Robert Mather. Paper prepared for the Am. Acad. of Pol. & Soc. Science. Shows the interstate effect of state rates, giving charts. 5000 w. R R Gaz—April 17, 1908. No. 91763.

MISCELLANY.

Forestry.

The Necessity for Corporation Forestry. E. A. Sterling. Gives information in regard to timber scarcity, discussing the difficulties, and the need of the practice of forestry. Discussion. Ills. 7500 w. Pro Engrs' Club of Phila—Jan., 1908. No. 91628 D.

STREET AND ELECTRIC RAILWAYS

Accounting.

Depreciation in Electric Railway Accounting. Daniel Royse. Read before the Ohio St. & Int. Ry. Assn. Discusses the proposed classification of accounts of the Interstate Commerce Commission contained in Circular No. 20. 5000 w. St Ry Jour—April 25, 1908. No. 91897.

Adhesion System.

The Chamonix-Martigny Railway. Illustrated description of an electrically operated line between France and Switzerland, partly on the adhesion system and partly on the rack system. 1600 w. Engr, Lond—March 27, 1908. No. 91464 A.

Austria.

Electric Traction in Austria (Die elektrischen Bahnbetriebe in Oesterreich). Wolfgang Adolf Müller. A statistical article giving the development of electric traction in Austria and extensive physical and financial data regarding the construction and operation of the lines. Ills. 3200 w. Elek Kraft u Bahnen—Feb. 14, 1908. No. 91556 D.

See also Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Berlin.

The Increase in the Capacity of the Berlin City and Belt Line Railway (Studie über die Erhöhung der Leistungsfahigkeit der Berliner Stadt- und Ringbahn). J. W. van Heys. Discusses various aspects of the recent project for the electrification of this steam railway. Ills. 2200 w. Se-

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rial. 1st part. Elek Kraft u Bahnen—Mar. 14, 1908. No. 91560 D.

See also Subways, under STREET AND ELECTRIC RAILWAYS.

Car Barns.

Construction of Car Barns. New standard rules and requirements of the National Board of Fire Underwriters. 2400 w. Ins Engng—April, 1908. No. 91718 C.

New Car House and Shops of the Chattanooga Railways Company. Illustrated description of these buildings and their equipment. 1800 w. St Ry Jour—April 18, 1908. No. 91760.

The Broadway Car House of the International Railway Company. Thomas Pumfrey. Illustrated description of a structure in Buffalo, N. Y. 2500 w. Elec Ry Rev—April 18, 1908. No. 91796.

Car Cleaning.

See Car Inspection, under STREET AND ELECTRIC RAILWAYS.

Car Department.

The Car Equipment Department of the Interborough Rapid Transit Company—Methods of Car Inspection, Lubrication Practice, Car Cleaning and Labor Payment. Illustrates and describes the facilities for inspection and the records of the department; also the inspection and cleaning practices. 7000 w. St Ry Jour—April 4, 1908. Serial. 1st part. No. 91344.

Car Inspection.

Car Inspection Based on Mileage. Editorial explaining the system of inspection on the Interborough Rapid Transit Railway in New York. 1000 w. Ry & Loc Engng—April, 1908. No. 91420 C.

Maintaining Car Equipment on the Chicago City Railway. An illustrated description of the inspection and maintenance practice. 3000 w. St Ry Jour—April 11, 1908. No. 91612.

Car Cleaning and Inspection—Chicago City Railway. Describes the methods of inspection, making light repairs and car cleaning, illustrating the shops, and outlining the general idea upon which the work is based. 3800 w. Elec Ry Rev—April 4, 1908. No. 91419.

Car Repairing.

Maintenance of Rolling Stock by the Indiana Union Traction Company. Information in regard to the methods adopted at the repair shops. Ills. 3500 w. St Ry Jour—April 4, 1908. No. 91348.

The Car Depot Record System of the Boston Elevated Railway Company. Explains a very satisfactory system of reporting and investigating car defects. 3500 w. St Ry Jour—April 4, 1908. No. 91351.

See also Car Inspection, under STREET AND ELECTRIC RAILWAYS.

Cars.

Northwestern Elevated Railroad—New Trailer Cars, with Steel Underframes and Sliding Side Doors. Illustrated description. 1200 w. Elec Ry Rev—April 25, 1908. No. 91964.

Controllers.

Subway Electric Control. W. B. Kouwenhoven. Illustrated description of the automatically operated controller used in the New York Subway, and its operation. 1100 w. Ry & Loc Engng—April, 1908. No. 91423 C.

Electrification.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Fares.

Handling Fares on Interurban Railways. P. P. Crafts. Read before the Ohio St. Int. Ry. Assn. Gives the most universally used systems, and the various combinations of duplex checks, describing the system of fare collection and accounting on two lines. 3000 w. St Ry Jour—April 25, 1908. No. 91896.

Interurban.

Twelve-Hundred-Volt System of the Indianapolis & Louisville Traction Company. H. D. Murdock. Abstract of paper read before the Cent. Elec. Ry. Assn. Principally a description of the electrical apparatus used on the cars and in the power house, and the operation of the system. 2000 w. Elec Ry Rev—March 28, 1908. No. 91355.

Locomotive Performance.

Railway Calculations. Malcolm MacLaren. Gives illustrations from tests on the N. Y., N. H. & H. Ry., showing the close agreement between theory and practice. 1000 w. Elec Jour—April, 1908. No. 91477.

Locomotives.

See Electrification, under RAILWAY ENGINEERING, MOTIVE POWER. AND EQUIPMENT.

Maintenance.

Maintenance of Overhead Lines and Electrical Equipment by the Indiana Union Traction Company. An explanation of the interesting features of the system. 2000 w. St Ry Jour—April 18, 1908. No. 91761.

Memphis, Tenn.

Reconstruction of the Memphis Street Railway System. Illustrates and describes work including tracks, overhead construction, trolleys, feeders, power house improvements, etc., connected with the recent extensions. 1200 w. St Ry Jour—April 4, 1908. No. 91346.

Shops.

New Repair Shops of the York Railways Company. Brief illustrated descrip-

We supply copies of these articles. See page 495.

tion of shops at York, Pa. 900 w. Elec Ry Rev—April 11, 1908. No. 91690.

Changes in Shops and Shop Practice by the New York & Queens County Railway Company Due to the Adoption of All-Steel Cars. All-steel cars were adopted in preparation for the use of the 42nd St. tunnel under the East River, and the shop changes and equipment of the repair shops is illustrated and described. 3000 w. St Ry Jour—April 4, 1908. No. 91350.

See also Car Barns, under STREET AND ELECTRIC RAILWAYS.

Single Phase.

Discussion on "The New Haven System of Single-Phase Distribution, with Special Reference to Sectionalization," at New York, January 10, 1908. Discusses W. S. Murray's paper. 4000 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91702 D.

Murnan-Oberammergau Single-Phase Railway. Cyril J. Hopkins. Gives an outline of the general conditions of the system, giving information in regard to first and annual costs. Ills. 3000 w. Elec Rev, N Y—April 4, 1908. No. 91360.

The Thomson-Houston System of Single Phase Electric Traction on European Railways (La Traction Electrique par Courant Alternatif Simple sur les Chemins de Fer en Europe, Système Thomson-Houston). M. Henry. A general description. Ills. 2500 w. L'Elecn—Mar. 7, 1908. No. 91521 D.

Subways.

Belmont, Interborough and Manhattan, and Hudson River Tunnels. A series of addresses by engineers describing their equipment for electric traction. 19600 w. Pro N Y R R Club—March 20, 1908. No. 91749.

The East River Tubes Connecting New York and Brooklyn. An illustrated description of the construction of the subaqueous tunnels and the electropneumatic block signaling and interlocking system. 5000 w. Elec Rev, N Y—April 11, 1908. No. 91615.

Progress on the Bridge Loop Subway. Explains the difficulties due to the interference with sewers, pipes, conduits, pneumatic postal tubes, gas and water mains, vaults and cellar walls, and illustrates and describes the work accomplished. 2800 w. Eng Rec—April 4, 1908. No. 91405.

The Completion of the First Tramway Subway in London. Illustrated description of the extension connecting the subway under Aldwych with the tramways on the Victoria Embankment. 1000 w. Tram & Ry Wld—April 2, 1908. No. 91767 B

The Tunnel Projects of Great Berlin Street Railway (Die Tunnelentwürfe der Grossen Berliner Strassenbahn). The first part discusses the project in the light of experiences with the Boston subway. Ills. 2000 w. Serial. 1st part. Elek Kraft u Bahnen—Mar. 24, 1908. No. 91561 D.

See also Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Subway Signalling.

Tunnel Indicator. Illustrated description of the apparatus used to show the position of trains in either of the twin tubes under the East River at New York. 1000 w. Ry & Loc Engng—April, 1908. No. 91424 C.

See also Subways, under STREET AND ELECTRIC RAILWAYS.

Switzerland.

See Adhesion System, under STREET AND ELECTRIC RAILWAYS.

Terminals.

Underground Bridge Terminal in New York for Brooklyn Surface and "L" Lines. Illustrates and describes the large underground terminal at the Delancey St. end of the Williamsburg Bridge. 1500 w. St Ry Jour—April 11, 1908. No. 91611.

Track Construction.

The Proper Construction and Maintenance of Tracks in Electric Railway Service. H. L. Weber. Considers points that determine whether tracks should be permanent, or temporary; the requisites of good tracks, and their maintenance, and related matters. 2500 w. St. Ry Jour—April 4, 1908. No. 91347.

Special Methods Employed in Tearing Out Old Concrete Roadbed for Cable Railway and Rebuilding for Electric Railway. Illustrates and describes machines and methods used on recent work in San Francisco. 600 w. Engng-Con—March 11, 1908. No. 90806.

Trucks.

Electric Motor and Trailer Trucks. A. C. Vauclain. Abstract of paper read before the Cent. Elec. Ry. Assn. Discusses their design and construction, illustrating types. 4000 w. St Ry Jour—April 4, 1908. No. 91352.

Single-Axle Trucks for Street Cars (Einachsige Drehgestelle für Strassenbahnwagen). M. Schiff. A general discussion of their utility and a consideration of types in use. 2300 w. Elek Kraft u Bahnen—Feb. 4, 1908. No. 91555 D.

Trunk Lines.

The Organization of an Economical Operation of Trunk Lines with Light Traffic and of Branch Lines (Organisation eines ökonomischen Betriebes auf Hauptbahnlinien mit Schwachem Verkehr und auf Sekundärbahnen). A general discussion, reviewing the practice of various countries. 13000 w. Mit d Ver f d Förd d Lokal- u Strassenbahnwesens—Feb., 1908. No. 91535 F.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill.—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Science. *w.* Denver, U. S. A.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.